BARRIERS IN MOTIVATION TO PURSUE A STEM CAREER AMONG STUDENTS FROM LOW SOCIOECONOMIC BACKGROUNDS: A TRANSCENDENTAL PHENOMENOLOGICAL STUDY

by

Daniel Khanh Lieu

Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Philosophy

Liberty University

2022

BARRIERS IN MOTIVATION TO PURSUE A STEM CAREER AMONG STUDENTS FROM LOW SOCIOECONOMIC BACKGROUNDS: A TRANSCENDENTAL PHENOMENOLOGICAL STUDY

by Daniel Khanh Lieu

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Philosophy

Liberty University, Lynchburg, VA

2022

APPROVED BY:

Sherrita Rogers, Ed.D., Committee Chair

Tracey Pritchard, Ed.D., Committee Member

Abstract

The purpose of this transcendental phenomenological study was to describe the lived experiences of students from low socioeconomic backgrounds that chose to pursue a career in STEM at STEM High School. For the purposes of this study, students from low socioeconomic backgrounds were generally defined as students that qualify for the free and reduced lunch program and STEM careers would be generally defined as any careers in science, technology, engineering, or mathematics. The theory that guided this study was Vroom's expectancy-value theory, which discusses how the individual perceived the outcome to occur (expectancy) and the worth of the outcome on the individual (value) as two predictors of whether an individual would place their foundation for their actions and behaviors towards achieving an outcome. This theory guided the study focused on describing the experiences of students from low socioeconomic backgrounds and factors within their experiences that were barriers and motivators towards their desire to pursue a STEM career. The study occurred in a Southern California high school with 10 participants within the study. Data were gathered through observations, interviews, and focus groups, which was then analyzed and synthesized into similar themes experienced among the participants. Eight major themes and five sub themes were identified from the analysis of the participant experiences. These major themes were early exposure, hands on learning, informal learning, real-world learning, greater purpose, external support, accessibility of teacher, and lecture focused environment. Additional research is required to continue exploring the long-term impact of increasing informal learning environments that engage students in hands-on learning at a young age on STEM retention, as well as the long-term impact of barriers, such as non-interactive and lecture-focused courses, on STEM motivation.

Keywords: STEM education, barrier, motivations, low-income backgrounds

Copyright Page

Dedication

I dedicate this dissertation to my wife, Monica, who is my best friend, and has been by my side encouraging me to keep moving forward despite how long the process can get. You have been a source of unwavering support and I'm incredibly lucky to have you cheering me on. You have been there for me through the stress of my teaching credential/student teaching, first year of teaching growth pains, masters, admin credential, doctorate, and whatever else came along in the process. I know that as long as this journey in school has been for me, it has also been just as long for you being by my side. Thank you for your patience and prayers. For the first time in my life, I'm finally not a student, and I'm excited to see what life together will look like in this next stage. I love you!

I dedicate this to my family, who has never stopped believing in me and taught me to place God above all things. Dad, thank you for teaching me how to be a leader and always pushing me to learn new things. Mom, thanks for being an inspiration to me as a teacher and role-model in my career. Peter and Jeffrey, thanks for being there for me and walking with me through my journey to learn how to be a loving and caring brother. And to my now extension of my family, my in-laws, thank you for raising such an amazing daughter and also being an example of Christ's love for others through your actions and love for me. Love you all.

Acknowledgments

I'd like to thank God and recognize that all of this would not have been possible without His strength that He's poured into me. Throughout this journey, there are so many times when I want to just settle with my masters, but I'm reminded by those all around me to continue putting my faith in Christ. My foundational beliefs as a Christian, my church, family, and community of friends, have built me to be the person that I am today. I am thankful for it all.

Table of Contents

List of Tables

List of Abbreviations

Association of Christian Schools International (ACSI)

Free and Reduced Lunch Program (FRLP)

National Center for Education Statistics (NCES)

Science, technology, engineering, mathematics (STEM)

CHAPTER ONE: INTRODUCTION

Overview

In 2020, the Bureau of Labor Statistics predicted that the number of jobs within science, technology, engineering, and mathematics (STEM) careers would increase by 1,000,000 available jobs (Bureau of Labor Statistics, 2019). However, the number of students from low-income backgrounds entering STEM was drastically lower than the number of students from more affluent backgrounds (Diekman & Benson-Greenwald, 2018). This chapter provides a background on the current shortage in STEM careers and the influence of education on addressing the gap. The historical context describes the rapidly advancing STEM industry, the importance of fulfilling these jobs as a means of economic competitiveness, and the policies that were currently in place as a means of addressing the gaps in education. From a social perspective, gaps in the number of students entering STEM careers from low socioeconomic communities display an equity issue that needs to be addressed by understanding how students are impacted and what barriers exist. Rozek et al. (2019) found that not only is the gap apparent, but it is also continuing to widen as the number of jobs increase between the number of graduates fulfilling these roles from low socioeconomic communities and wealthy communities. The significance of this study is also addressed in context of current literature, specifically on students from low-income communities. The three research questions that served as the foundation for the study are also described within this chapter, followed by key definitions of terms within the study.

Background

STEM education focuses on building authentic, real-world learning in an effort to prepare students for careers in STEM. However, in 2018 the number of jobs that were available and the number of students that were ready to fulfill those careers was disproportionately widening, with many jobs still unfilled (Diekman & Benson-Greenwald, 2018). This gap was even more prevalent within low-income communities, with less students that chose to pursue a STEM career in comparison to their peers from more affluent communities (Rozek et al., 2019). The following section explores the background of STEM education from a historical, social, and theoretical context.

Historical Context

The number of careers within STEM has rapidly increased throughout the past few years. While the average non-STEM job increased at a rate of 11% over a period of 10 years, STEM jobs increased at a rate of 13% (Bureau of Labor Statistics, 2014). Additionally, STEM fields have made strides towards increasing diversity in the workplace since 1990. Previously, 83% of STEM professionals were white and 17% from underrepresented backgrounds, whereas now, that number has decreased to 69% white workers and 31% are from underrepresented backgrounds (IPUMS, 2016). Despite this growth and progress towards increased diversity in the workplace, diversity among professionals from different socioeconomic backgrounds remains low and the gap is continuing to widen (Diekman & Benson-Greenwald, 2018; Rozek et al., 2019). Diekman and Benson-Greenwald (2018) found that students from low-income communities were far less likely to pursue STEM careers than their peers from high-income communities. This became increasingly important to address as America found the number of students from low socioeconomic backgrounds in public schools increased from 12% in 1999 to 25% in 2014 (Hussar et al., 2010; United States Department of Education, 2016). With the rapidly increasing number of STEM jobs and progress towards racial diversity, the presence of students from low-income communities in STEM failed to maintain that same growth, which was especially important as these careers were key factors in the growth and competitiveness of America (Deming & Noray, 2018).

The historical context of students from low-income backgrounds and STEM self-efficacy was important to acknowledge as the first factor contributing towards the gap. As STEM careers continued to increase, the United States emphasized the importance of understanding STEM readiness through benchmarking with course content proficiency exams, or standardized tests. Mattern et al. (2015) found that most U.S. students were not STEM ready, as only 26% of students performed at the proficient baseline. In addition to this, they found that less than 50% of students expressed motivation to enter a STEM career. Student perceptions and attitudes towards STEM jobs are affected by motivation and self-efficacy (Roberts et al., 2018). Motivation within STEM was found to be influenced by formal and informal learning environments. Kitchen et al. (2018) found that informal learning environments outside of the classroom displayed a positive influence on student motivation, while formal learning environments influenced students to have lower motivation and self-efficacy. The issue presented itself through looking at most current secondary school systems and finding that STEM education is primarily focused on formal learning environments, which negatively impacted students from low-income communities that benefitted from informal learning environments. Low access to STEM education in both formal and informal learning environments was found to influence readiness in STEM, which contributed to a decreased amount of students from low-socioeconomic backgrounds that chose to pursue a career in STEM (Kitchen et al., 2018; Roberts et al., 2018).

As a result of these findings that students from low-income communities were not fulfilling STEM careers as much as their peers from high-income backgrounds, there was increased emphasis on increased funding to schools from these communities. There was increased focus on discussions around technology integration within school classrooms through tools like Kahoot, iPads, Chromebooks, and the Google Suite (DeCoito & Richardson, 2018). Additionally, with these discussions, there was an increased focus on not only how technology could continue to be integrated within the classroom, but also how the technology could be integrated within the means of an equitable learning environment (Davies & West, 2014). As technology continued to advance and continued to be integrated within the classroom, external challenges still existed as barriers towards its integration specifically in Title 1 schools. While the technology may have been within the classroom, access, training, and support were still factors that may have prevented effective integration of tools (Johnson et al., 2016). By determining how to integrate technology and prepare students for STEM careers, active steps have been taken towards increasing access to technology, while more work needs to be done towards increasing motivation in STEM.

The theory that drives this study is Vroom's (1994) expectancy-value theory, which discusses how the individual perceives the outcome to occur (expectancy) and the worth of the outcome on the individual (value) as two predictors of whether an individual will place their foundation for their actions and behaviors towards achieving an outcome. Not only was it important to understand factors that impact a student's academic self-efficacy, but it was also important to understand the lived experiences of students pursuing STEM from low-income backgrounds and how their experiences shaped their perception of the expected outcome and value of STEM careers. The research that was conducted in this study advances this theory by providing an understanding of how students' lived experiences influence expectancy and value, which reiterates the importance of expectancy and value in making decisions. This study provides an application for the theory that is focused on STEM careers.

Social Context

Access to STEM education is broad and influenced by factors such as socioeconomic status. Roberts et al. (2018) looked at individuals' motivation to enter a STEM career depending on the school they attended. They found that students in underrepresented groups, or students from low-income backgrounds and/or students from diverse backgrounds, were less likely to enter a STEM field, while those in underrepresented groups that attended specialized STEM high schools were more likely to enter a STEM career. Underrepresented students who attended specialized schools also displayed higher self-efficacy towards STEM than those who did not (Salto et al., 2014). In low socioeconomic areas, students are less likely to have opportunities to have summer intensives that have been shown to increase STEM readiness. Through the combination of low motivation and self-efficacy in STEM and the wide disparity in STEM opportunities in schools, the shortage of future professionals will continue until these can be addressed (Betancur, Votruba-Drazl, & Schunn, 2018).

This phenomenon of students from low-income backgrounds being less likely to enter STEM careers is highlighted further because the number of jobs in STEM is continuing to increase faster than the pace at which graduates are ready to fulfill those roles (Kitchen et al., 2018). Additionally, these graduates are less likely to come from low-income backgrounds, a gap that is continuing to widen. A few factors that have been identified as contributing to this issue are decreased access to afterschool STEM programs and less exposure to STEM within their family backgrounds (Kitchen et al., 2018; Roberts et al., 2018). These factors shape the current programs and emphasis to increase the number of STEM informal learning environments, encouraging more students from these backgrounds to pursue STEM careers (Kaleva et al., 2019;

Maiorca et al., 2021). Learning about the experiences of students from low-income backgrounds that are choosing to pursue careers in STEM can shape the future of education and pave the way for other students.

Theoretical Context

Within research, several theories and frameworks were identified as common themes. Vroom's 1994 expectancy-value theory describes the influence of an individual's perception of the outcome (expectancy) and the value as two foundational predictors towards behavior (Wigfield et al., 2009). Students from low-income backgrounds were less likely to perceive a positive outcome and value towards pursuing a career in STEM (Wu, 2019). Additionally, An et al. (2019) found that of the factors that influence student desire to enter a STEM career, socioeconomic environment and parents' education levels were the strongest. Despite this, they found that changing the environment by increasing parental participation in the students' educational level positively impacted student desire to pursue STEM careers. A commonly shared understanding of the impacts of socioeconomic status and backgrounds of students has allowed researchers to continue making educational decisions through research to address the gaps presented.

By understanding what influenced students to pursue STEM and what outcome they perceived by choosing to pursue these careers, the impact of applying Vroom's expectancy-value theory within the context of STEM education could be positively influential. Environmental and social upbringing were predictors of whether students would enter STEM careers (Lee & Burkam, 2002). Students from low-income backgrounds were less likely to desire to enter STEM careers due to decreased exposure to STEM in their upbringing, parental and role model influence, and social influence of their peers (An et al., 2019; Lee & Burkam, 2002). Utilizing the expectancy-value theory within the context of STEM education would allow for understanding the impacts of these factors on student desire to enter STEM and the extent to which students from low-income backgrounds could be more influenced into STEM careers.

Problem Statement

The problem is that as the number of unfilled jobs within STEM has continued to increase, the gap between STEM graduates from low-income communities and affluent communities has continued to widen. As a result, fewer students from low-income backgrounds are equipped and prepared to fulfill these jobs, resulting in an increased equity issue. By describing the factors that motivate students to pursue STEM careers, educators could make stronger pedagogical decisions to allow more students to be motivated to pursue a career in STEM. Additionally, this could also allow for a more equitable classroom environment, where students from all backgrounds and socioeconomic statuses could enter STEM.

By understanding the factors and barriers that either motivate or prevent students with low socioeconomic backgrounds from pursuing a STEM career, greater understanding of why fewer of these students graduate with STEM-readiness in comparison to their peers from more affluent communities could be learned. This knowledge could be utilized to create instructional programs both in school and out of school that would be able to address this problem. While schools and communities from affluent and low-income areas may have been taught by similarly credentialed and highly effective teachers, there are differences in teaching pedagogy and curriculum that need to be considered (U.S. Department of Education, 2017). This research aids in the understanding of what differences in pedagogy and curriculum need to exist to create equitable learning environments.

Purpose Statement

The purpose of this transcendental phenomenological study was to describe the experiences of students from low socioeconomic backgrounds that intend to pursue a career in STEM at STEM High School. Careers in STEM are generally defined as any careers within science, technology, engineering, and mathematic disciplines. The theory that guided this study was Vroom's expectancy value theory, postulating that the motivation for pursuing a STEM career is motivated by the outcome expectancy and value of the decision (Wigfield et al., 2009).

Significance of the Study

While the number of available STEM jobs continues to increase, there are fewer students from low-income backgrounds that are filling those roles than their peers from high-income backgrounds (Roberts et al., 2018). Students from low-income backgrounds often experience a greater number of external factors that decrease their academic performance, often have lower academic self-efficacy, and experience more barriers to STEM than their peers (Kent & Giles, 2017; Kitchen et al., 2018; Liu & Fu, 2022). As a result, from a theoretical perspective, it is important that the experiences of students from low-income backgrounds are explored so that the barriers to STEM can be identified and targeted interventions put in place to limit the barriers. By applying expectancy-value theory to the experiences of low-income students, the expected outcome and perceived value of pursuing STEM can be better understood (Wigfield et al., 2019). This could lead to a greater understanding of how these barriers could be addressed to allow for a more equitable and diverse workforce.

Theoretical Perspective

Vroom's expectancy-value theory discusses an individual's perception of outcome (expectancy) and value of the outcome as foundational motivators of behavior (Wigfield et al., 2009). Students from low-income backgrounds are pursuing STEM at lower rates than their peers from more affluent backgrounds (Roberts et al., 2018). Additionally, perceived poverty among students from low-income backgrounds has been found to harm interpersonal relationships, academic self-efficacy, and psychological health and decision making (Liu & Fu, 2022). By exploring the experiences of students from low-income backgrounds choosing to pursue a career in STEM, themes were gathered that allow for a greater understanding of the barriers they face as a direct result of their low socioeconomic backgrounds. From a theoretical perspective, understanding the expected outcome and perceived value of students pursuing STEM from low-income backgrounds can lead to greater targeted interventions for addressing this phenomenon and contribute to a more equitable and diverse STEM industry.

Empirical Perspective

Current literature focuses on student motivation towards STEM careers, which makes this study significant because it builds on that foundation towards a more narrowed focus on low-income communities. While similar researchers utilized a broader research focus (Kent & Giles, 2017; Kitchen et al., 2018; Roberts et al., 2018), they acknowledged that different student groups, locations, and backgrounds influenced their research on the effectiveness of specific instructional interventions with differing populations. Bondie et al. (2019) studied the effects of a one-size-fits-all and a differentiated approach to instruction and found that within 4 grade levels, student academic achievement, performance, and learning processes differed drastically, calling for increased instructional supports and interventions dependent on students' cultural contexts and needs at the time. This study works as a means of further understanding the barriers that prevent students with low-income backgrounds from receiving instructional interventions that effectively teach and guide them towards STEM careers.

Practical Perspective

This study had several areas of practical significance. Identifying factors that influence student desire to pursue STEM allows educators to make more specific instructional interventions. As STEM continues to rapidly advance, the demand for careers in these fields and the number of jobs are also increasing (Means et al., 2018). As the United States remain at the forefront of economic prosperity and technology innovation, it is important that the phenomenon of low-income students not choosing STEM careers is addressed from an economic standpoint. Benson-Greenwalk (2018) found that China has surpassed the quantity of science and engineering degrees awarded to students with consideration to population density. Research in this area is significant because it could allow more students from low-income communities to enter these careers, as low-income students entering STEM careers currently amount to less than half of the number of students from affluent communities (Reardon, 2011). This could provide a future with a more equitable education for students and minimize the barriers towards these careers for students from low socioeconomic backgrounds. Additionally, it could also allow for increased economic competition by utilizing education as a means of motivating students to fill gaps in the rapidly advancing STEM industry, maintaining economic competitiveness (Benson-Greenwalk, 2018; Means et al., 2018). The results of this study have theoretical significance for individuals within the STEM industry looking to fill jobs, curriculum developers, and teachers and administrators within Title 1 schools. This study describes experiences of participants specifically from low socioeconomic communities and their motivational beliefs that they perceive to be barriers or catalysts towards these careers.

Research Questions

The research questions, derived from the problem and purpose statements mentioned previously, were:

Central Research Question

What are the experiences of students from low socioeconomic backgrounds pursuing a career in STEM?

Identifying the key barriers that exist among students from low-income backgrounds is important because it addresses gaps in current literature and provides a foundation for understanding why some students are less likely to pursue these careers. Currently research and literature has focused on reasons why students were less likely to pursue STEM careers in a broad sense, where a few of the factors that were identified were low student self-efficacy and decreased exposure to STEM programs (Kent & Giles, 2017). The research that has been conducted addressed students in a broad sense, but it is also important to distinguish how students from low socioeconomic communities are less likely to pursue STEM careers than students from more affluent communities, citing a need for increased research in each of these specific groups. This research question provided the foundation for understanding student perceptions of why they choose to not enter a STEM career, which could allow for future instructional changes and academic interventions.

Sub-Question One

How does academic self-efficacy in students from low-income backgrounds affect their perceptions of the expected outcome and value of pursuing a career in STEM?

This question was important to address because academic self-efficacy plays a large role in student desire to pursue STEM careers (Kent & Giles, 2017). Additionally, as the primary theory that guided the research was expectancy-value theory, this question also aligned with that theory and provided a framework for understanding the extent to which self-efficacy plays a role in students perception of the outcome and value of pursuing STEM carreers. Students' beliefs regarding whether they believe they are able to be successful in these careers play a role in influencing their future career choices (Mattern et al., 2015; Means et al., 2018). As a result, understanding how self-efficacy influences motivation allowed the researcher to understand the current statistics on the number of students in these careers. In particular, this allowed for a greater understanding of how academic self-efficacy of students from low-income backgrounds influenced their perceived outcome and value of pursuing a STEM career.

Sub-Question Two

How do students perceive classroom interventions to affect their expectancy and value of pursuing a career in STEM?

It is just as important to understand which instructional interventions within the classroom support a student's perceived ability to enter a career in STEM. Additionally, illuminating how students perceive instructional interventions benefits teachers because they are then able to continue utilizing instructional practices in the classroom that work with the students. A student-centered classroom is one that utilizes instructional practices and pedagogy that meet the needs of the learners within the class. Understanding where the learners are in their desire to pursue STEM and the individual backgrounds of the learners is the first step. Instructional interventions that have been identified as student-centered correlated with an increased desire in student learning, motivation, and higher cognitive demand compared to classes that were not student-centered (Boddy et al., 2003). Ensuring that student-centered approaches are integrated in STEM classes is also vital towards ensuring a class where all students feel included and represented within the content (Keiler, 2018). By studying which instructional interventions students believe are strongly shaping their belief and motivation in STEM, more action steps can be taken towards ensuring an equitable classroom environment.

Definitions

1. *Academic Self-Efficacy* – "Students' beliefs and attitudes towards their capabilities to achieve academic success, as well as their ability to fulfill academic tasks and the successful learning of the materials," (Hayat et al., 2020).
2. *Attitude* – Favor or disfavor as a result of a psychological tendency that is derived towards a particular topic or entity (Eagly & Chaiken, 1993).
3. *High-Income* – Not meeting the qualifications for the free and reduced lunch program (California Department of Education, 2021).
4. *Low-Income* – A financial background that qualifies a person for the California free and reduced lunch program, determined by an income level that is 125 percent of the federal poverty level with consideration to family size (California Department of Education, 2021).
5. *Motivation* – "The driver of guidance, control, and persistence in human behavior," (Tohidi & Jabbari, 2011).
6. *Self-efficacy* – A person's belief in their ability to perform and behave in a way that produces an intended result (Carey & Forsyth, 2008).
7. *STEM* – Science, technology, engineering, and mathematics education (Li, 2018).
8. *STEM Readiness* – A person's level of knowledge and skills that are relevant in succeeding as a STEM major (Li, 2018).

9. *STEM Shortage* – A greater number of STEM jobs than qualified STEM graduates and professionals (Bureau of Labor Statistics, 2015).
10. *Title-1 School* – Federally funded program that provides services to schools consisting of at least 40% of students with low-income backgrounds (California Department of Education, 2020).

Summary

As the number of unfilled jobs within STEM continues to increase, the STEM gap between graduates from wealthy and low-income communities continues to widen. The importance of educational interventions to ensure equitable learning environments remains critical. Previous research has addressed the barriers that prevent students from entering STEM careers broadly; however, there are still gaps in literature concerning how self-efficacy and barriers such as low access to STEM education affect student decisions to pursue careers in STEM. Additionally, while Mattern et al. (2015), Roberts et al., (2018), and Kitchen et al. (2018) researched motivation to pursue STEM careers, they did not specifically identify student perceptions of specific instructional interventions that addressed their desire to pursue STEM careers. By identifying which instructional practices work towards improving student perception and desire for STEM, these gaps can be better addressed within education. In summary, the purpose of this phenomenological study was to describe the lived experiences of students from low-income backgrounds that choose to pursue a career in STEM at STEM High School; this research was motivated by the phenomenon of fewer students with low-income backgrounds pursuing STEM than their peers from affluent backgrounds (Roberts et al., 2018).

CHAPTER TWO: LITERATURE REVIEW

Overview

Students from low socioeconomic backgrounds are less likely to enter STEM careers than their peers from high socioeconomic backgrounds as a result of increased external stressors, testing as a barrier to entry, limited exposure to role models, and the impact of these factors on academic self-efficacy (Chen, 2015; Deming & Noray, 2018; Diekman & Benson-Greenwald, 2018). These factors, including the prior experiences of students, all influence student expectancy and values. These two factors influence student actions and behaviors of a particular task (Vroom, 1964). Appaining and Eck (2018) found that students from low-income backgrounds were less likely to pursue a STEM career, and female students in particular are 1.5 times more likely to change their major to a non-STEM major. By understanding the statistics of student attrition rates within STEM among male and female students, researchers are able to utilize these findings to understand the factors that influence motivation. These factors have contributed to the high rate of students from low-income backgrounds that do not enter STEM careers or drop out (Appaining & Eck, 2018; Shaw & Barbuti, 2010). This study utilized expectancy-value theory (Vroom, 1994) as the framework for understanding what factors motivate students from low-income backgrounds to pursue careers in STEM. This study also sought to understand the lived experiences of students from low-income backgrounds and the barriers that prevent these students from entering careers in STEM. The following sections discuss the theoretical framework and related literature on factors that contribute to the current understanding of barriers to STEM among students from low-income backgrounds.

Theoretical Framework

This study utilized expectancy-value theory (Vroom, 1994) as the theoretical framework, which guided the study and was the context within which the results were situated. There are various interpretations of expectancy-value theory from different theorists, which include Vroom (1964), Lawler and Porter (1967), and Wigfield (2000), amongst others. Vroom (1964) stated that the actions and behaviors of an individual are determined by how the individual perceives the outcome to occur (expectancy) and the worth of the outcome on the individual (value). Expectancy-value theory is defined as a basis and predictor for how an individual's actions and behaviors are influenced. These actions and behaviors are influenced by how strongly an individual perceives the worth of the outcome (Vroom, 1964). Lawler and Porter (1967) elaborated on how individuals perceive worth and value by explaining that it is the ability for the expected outcome to satisfy a person's desire for security, esteem, self-actualization, and autonomy.

Expectancy-value theory shifts from seeking to understand how behavior is influenced by perception of the worth and outcome into implications for teaching and learning. Wigfield and Eccles (2000) theorized that the factors which influence the values of a person are the person's beliefs, past or current personal experiences, achievement, and socialization. The foundation from which students perceive the expected outcomes and value of a task stems from moments when they may have achieved a positive result in the past and moments when they had experience or were exposed to the task (Wigfield & Eccles, 2000). Whether those experiences in the past have resulted in an increase of security, self-actualization, and other characteristics identified by Lawler and Porter (1967) could determine whether there will be a positive or negative contribution towards the perceived value of an action by an individual. For students in two particular studies, as they encountered positive and negative outcomes from their actions, these outcomes influenced their perceived expectancy and value of the action in the future (Lawler & Porter, 1967; Wigfield & Eccles, 2000).

As the current understanding of expectancy-value theory continues to expand, the understanding of how this theory influences teaching and learning also continues to develop. Vroom (1964) and Lawler and Porter (1967) initially described expectancy and value and how the two beliefs influence action. Eccles and Wigfield (1983) expanded upon their initial description as they explored the intersection between the theory and education by dividing achievement-related choices into four domains. These four domains were attainment value, intrinsic value, utility value, and cost value. Actions and behaviors were said to be based on expectancy and value, which were influenced by smaller factors, one of which was achievement. These four domains allegedly described how achievement-related choices were influenced (Eccles & Wigfield, 1983; Vroom, 1964). Attainment value focused on the importance of doing well, while intrinsic value was described as the personal enjoyment of the task. Utility value was the perceived usefulness for the intended action on future consequences. and cost was defined as the outcome worth as compared with outcomes of other goals. These four factors influenced the individuals' expectations of success and was an indicator of the importance placed on achievement of one goal over another (Eccles & Wigfield, 1983). Although many theorists vary in their interpretation of expectancy value theory, a theme shared across all educational theorists regarding teaching and learning is that an individual's expectations for success are influenced by how they perceive their competency for tasks, which is influenced by positive and negative outcomes over time (Eccles et al., 1983; Eccles & Wigfield, 2002; Wigfield & Eccles, 2001).

Expectancy-value theory has informed the literature on student motivation to pursue careers in STEM by being the foundation by which educational researchers seek to understand motivating factors (Appaining & Van Eck, 2018). Vroom (1964) and Lawler and Porter (1967) stated that achievement-related choices, in this case the desire for a student to choose a STEM career, are based upon the expectancy of whether students believe that the goal can be attained and the value the action holds. How students are affected by their previous experiences in STEM, belief of competency, and attainment value of entering STEM could be determined by looking at past student experiences (Eccles & Wigfield, 2002). This theory serves as the foundation of many studies attempting to understand the impacts of past experiences on student desires to pursue STEM careers.

Not only does this framework serve as the foundation for understanding the motivation of students from low-income backgrounds to pursue STEM careers, but it has also been pivotal towards understanding this phenomenon within underrepresented groups and female students. Students from low-income backgrounds, unrepresented groups, and female students are all focus groups with expectancy-value theory because they have been found to be historically less likely to enter STEM than their peers in other groups (Beede et al., 2011). Expectancy-value theory was the framework for a particular study that suggested values and expectations served as predictors for whether female students were more likely to enter a career in STEM (Appaining & Eck, 2018). By using a Value-Expectancy STEM Assessment Scale, researchers found that women were less likely to remain in STEM and had an attrition rate that was 1.5 times greater than male students. As a result of these findings, they were able to focus their efforts on utilizing the research as supporting evidence towards future studies on understanding what would allow women in STEM to remain in STEM (Appaining & Eck, 2018). By understanding perceived value, the influence of previous experiences, belief of competency and attainment value, researchers can utilize expectancy-value theory to shape the future of education and ensure equity for all students (Appaining & Eck, 2018; Eccles & Wigfield, 2002; Lawler & Porter, 1967).

Just as Appaining and Eck (2018) studied the impact of varying factors on student desire to remain in STEM and motivation to pursue a STEM career, others have also dedicated themselves to understanding this phenomenon among students from low-income backgrounds utilizing an expectancy-value theory framework. These findings were also similar to other studies, where researchers found that students from low-income backgrounds were just as likely to either not pursue careers in STEM or change to a non-STEM major after declaring their major (Appaining & Eck, 2018; Shaw & Barbuti, 2010). Additional research on the impacts of student backgrounds, experiences in STEM classrooms, and overall perceptions of STEM still need to be conducted for students from low-income backgrounds. This would be important in understanding how students from low-income backgrounds perceive value and believe the expected outcome to occur should they choose a STEM career, and how this influences their motivation to pursue a STEM career. This study sought to address these gaps in literature by utilizing expectancy-value theory as the framework.

Related Literature

Students from low socioeconomic backgrounds are less likely to pursue careers in STEM, which has led to an increased focus on identifying why this phenomenon is occurring, the contributing factors, and the steps that could be taken to address this problem (Rozek et al., 2019). There is also a gap between the rapidly increasing number of jobs in STEM and the number of graduates that are qualified to fill those roles (Chen, 2015; Diekman & Benson-

Greenwald, 2018; Deming & Noray, 2018). In addition, the gap between the number of students that are filling those roles from low-income and affluent backgrounds continues to increase (Wyss et al., 2012). Various researchers have studied the reasons why students from low socioeconomic backgrounds are less likely to pursue a career in STEM. A few of the identified factors are increased STEM attrition due to testing as a barrier of entry, differences in upbringing that lead to decreased self-efficacy, and less access to STEM learning experiences and role models (Blotnicky et al., 2018; Brito & Noble, 2009; McKenzie, 2019; Wang, 2013). Despite the numerous research studies on these topics, significant gaps still exist within literature that warrant the need for further study. Previous research has implemented external variables and analyzed how this affected students' self-efficacy, motivation, and desire to pursue a career in STEM. There is limited research that explores student perceptions of the experiences within the classroom and their impact on motivation to pursue STEM careers among students from low-socioeconomic backgrounds (Roberts et al., 2018). The following section explores three key research areas on the topic of student motivation to pursue a career in STEM, as well as presents the current gaps in the literature on this topic.

Socioeconomic Status and STEM Education

Research has indicated that students from low-income backgrounds are less likely to enroll in higher education (DeNavas-Walt & Proctor, 2015). Moreover, students that did enroll were less likely to be successful than their peers that were not from low-income backgrounds (Renbarger & Long, 2019). For the purposes of this study, low-income is defined within the educational setting as students that come from families below 125 percent of the federal poverty level with consideration to family size (United States Department of Education, 2000). Students that do not meet the defined criteria for low-income students according to the criteria established by the United States Department of Education are defined as students from high socioeconomic backgrounds for the purposes of this study. It was important to define the difference between students from low-income settings and students that are not from low-income settings because student socioeconomic background is also associated with student experiences. With these varying differences and challenges, students exhibit different strengths, challenges, prior knowledge, and gaps in both academic and social development (Kubat, 2018).

As the impact of socioeconomic background influences student academic achievement, researchers have sought to explore the number of students that are affected. In 2014, 21.1% of school-aged children, or children under 18 years old, qualified as low-income because their families had an income that was below the federal poverty line (DeNavas-Walt & Proctor, 2015). The income disparity continued to increase and the gap between students from low-income and high-income backgrounds grew wider in consideration to income and academic achievement (Autor, 2014; Piketty & Saez, 2014). As the percentage of children under the age of 18 living in poverty continued to increase from 18% in 2005 to 21.1% in 2014, the emphasis on studying the achievement gap in school between these students and students from high-income backgrounds became more critical (Capella et al., 2008; DeNavas-Walt & Proctor, 2015; Goldin & Katz, 2008; McCarty, 2016).

By understanding the type of learners within the classroom and their unique individual backgrounds, it has been found that teachers were more likely to create meaningful learning experiences appropriate to each student (Kubat, 2018; U.S. Department of Education, 2000). Teachers were more likely to develop instructional strategies that support learning and development of those learning (Kubat, 2018; U.S. Department of Education, 2000). The American Psychological Association (2007) stated that socioeconomic background and the varying factors an individual experiences in low-income and high-income settings influenced lifespan and human behavior. In education, human behavior is commonly interpreted as academic persistence in academic environments and is a factor that is considered an indicator of academic achievement (Buckley & Puchner, 2015; Sandoval-Palis et al., 2020). The determining factors of academic achievement for students from low socioeconomic backgrounds are academic achievement gaps, increased need for role-models in careers that required higher education and increased external stressors in comparison to their peers from high socioeconomic backgrounds (Arias & Bueno, 2016; Ferguson, Bovaird, & Mueller, 2007; Levin, 2007).

Governmental Programs and Academic Achievement Gap

Studies on academic achievement began spreading from the study of teacher interventions and their effect on students from low-income backgrounds and schoolwide implementation of interventions to address the STEM shortage. This schoolwide implementation began through a focus on Title 1 schools, or schools where at least 40% of the total student population are from low-income backgrounds (California Department of Education, 2020). For the purposes of this study, schools that did not qualify for Title 1 funding according to the California Department of Education (2020) were classified as schools from high socioeconomic areas. Title 1 classification began after the implementation of the Elementary and Secondary Education Act (ESEA) of 1965, which resulted in increased funding to Title 1 schools to address achievement gaps. Socioeconomic status of students revealed equity gaps that needed to be addressed when the United States began to see a growing gap between the number of students that were entering STEM from low-income and high-income backgrounds (Sabochik, 2010).

The relationship between socioeconomic status and percentage of students from low-income and high-income backgrounds entering STEM careers became the focus of government intervention through the Change the Equation program and increased National Science Foundation (NSF) funding. Change the Equation, an organization launched by former President Barack Obama, aimed to improve STEM education by improving instructional quality and increasing access to STEM education (Sabochik, 2010; Silk et al., 2010). The organized was officially launched after the federal acknowledgement of economic segregation among low-income and affluent individuals during the rapid advancement of job creation within STEM careers (Change the Equation, 2017). Federal implementation of programs to address achievement-related gaps like Change the Equation was present long before this program. In 1965, the ESEA classification of Title 1 schools increased funding specifically to schools that primarily served students from low-income backgrounds, supporting research that would engage students to enter college or careers that would boost economic competitiveness (Murnane, 2007; Sabochik, 2010; Zinskie & Rea, 2016). Change the Equation was a program that was created as a result of the federal funding towards this focus, but it was a program that differed because it specifically focused on increasing the number of students from low-income backgrounds to enter STEM careers. Former President Barack Obama intended to address a specific gap of socioeconomic status and STEM education through this program (Change the Equation, 2017).

Not only has Change the Equation, a non-profit company, highlighted the importance of addressing the equity gap among students entering STEM from low-income backgrounds, but the National Science Foundation (NSF), a federal agency, has also played a role in closing the gap. The economic sector and focus within the government realized that economic competitiveness, which is a direct relation to government power and funding, rested in the future industries, which was identified as the STEM industry. This vision of education by the NSF focused on increasing STEM learning and providing equitable access to success in STEM, intending to increase the number of students from low socioeconomic backgrounds at the forefront of the vision (National Science Foundation, 2020).

Increased focus on socioeconomic status and STEM education from non-profit agencies and government agencies continues to highlight the importance of understanding how upbringing and income levels influence student motivation to pursue STEM careers and address these barriers (Ferguson, 2000; Kozol, 1991; Ong et al., 2011). The barriers that have been identified reveal a few common themes. Oscos-Sanchez et al. (2008) found that stereotype threat due to misrepresentation within STEM is a significant barrier to students from low-income backgrounds having success. Additionally, Museus et al. (2011) and Peng and Hill (1995) found that students from low-income backgrounds are less likely to have exposure to science careers, which contributes to these students being more inadequately prepared to enter STEM careers when compared to their peers from high-income backgrounds. The last theme, as a result of the increased focus on socioeconomic status and STEM education, highlights that the students from low-income backgrounds entering a STEM career are still more likely to encounter barriers and have a higher attrition rate as a result of these barriers (Major et al., 2018). The National Science Foundation and Change the Equation identified the same themes as Oscos-Sanchez (2008), Museus et al., (2011) and Peng and Hill (1995) and attempted to address these gaps within their programs (Sabochik, 2010).

Academic Factors Contributing to the Disparity

Academic factors have contributed towards the increasing disparity among students from low socioeconomic backgrounds pursuing a career in STEM. Academic factors include academic self-efficacy, testing as a barrier to entry, and courses that emphasize prior knowledge as a metric for academic success. These academic factors were barriers for students to enter

STEM careers and students from low-income backgrounds were even more impacted by these barriers. McKenzie (2019) and Brito and Noble (2009) highlighted that Grade Point Average (GPA) was dependent on factors beyond academic performance and was influenced by social and emotional challenges, increased stress, and cognitive lags as a result of environment. The barrier of testing to enter STEM careers was higher among students from low-income backgrounds because they encountered an increased number of academic factors that negatively impacted them. Additionally, Anderson and Kim (2006) and Chen (2015) found that as students encountered more barriers to STEM as the number of negative academic factors increased, their GPA decreased, which led to many of these students having a decreased preparedness and higher attrition rate. This was more prevalent among students from low-income backgrounds, even for those that did become STEM professionals, as these barriers impacted students even beyond college (Anderson & Kim, 2006; Chen, 2015; McKenzie, 2019). The influence of testing on GPA, especially as the only means of assessment, resulted in inequitable practices that continue to keep students from low-income backgrounds out of STEM. The following sections explore these topics in more depth, as well as how poverty affects testing, academic self-efficacy, and STEM career choice.

Poverty and Academic Achievement

Although STEM is the focus of this study, understanding the impacts of poverty on academic performance of students is important towards gaining an overall perspective on STEM attrition and motivation. Students from low-income backgrounds are more likely to encounter chronic stress and stressors as a result of divorce, separation from siblings, increased crime rates, and overall financial strain, which result in a higher likelihood of behavioral and academic challenges in school (Johnson, Riis, & Noble, 2009; McKenzie, 2019). Students from these backgrounds can not solely focus on school, have their focus shifted towards many priorities, have higher rates of absences, and as a result, have more difficulty remaining motivated and persistent academically (Jensen, 2009). Additionally, students that are from low-income backgrounds are more likely to attend schools with most other students also from low-income backgrounds, which furthers the detrimental dynamic on the effectiveness of education (Boschma & Brownstein, 2016; Jensen, 2009; Owens, Reardon, & Jencks, 2016). This results in an even greater barrier of entry into STEM careers than their peers from more affluent backgrounds because of the challenges that they must overcome in addition to motivation.

A key factor affecting the motivation of students from low-income backgrounds is a lack of available resources that could cultivate intrinsic motivation and support higher academic achievement. Johnson et al. (2016) found that students that are from low-income backgrounds are more likely to have a difficult time performing well in school because they are exposed to fewer books and toys than their peers from high-income backgrounds. They studied the effects of books and toys on children and found that the children who were exposed to books and toys at a young age demonstrated increased vocabulary and expansive speech compared to children that did not have access to either books or toys. Students from low-income backgrounds were also found less likely to have access to books and toys, which results in an achievement gap between low-income and high-income students before they even enter formal schooling (Johnson et al., 2016). The integration of science within the books and toys in a student's upbringing is integral towards STEM interest but is also a factor that is limited among students in poverty (English, 2016; English & Gainsburg, 2016; Vasquez et al., 2013). In addition, Jensen (2009) highlighted that many students from low-income backgrounds also encounter increased barriers in academic achievement in comparison to their peers because they have external stressors that shift their focus away from school, something that students from high-income backgrounds do not appear to experience. Rather than focusing on learning through books and toys prior to entering school, students from low-income backgrounds enter school with an existing achievement gap and decreased motivation (Jensen, 2009; Johnson et al., 2016).

Testing as a Barrier to STEM

Testing was found to be a barrier to STEM for students from low-income backgrounds as a result of being a singular means of measuring academic readiness and not accounting for increased obstacles due to income (Cotner & Ballen, 2017; Reardon, 2013). Students from low-income backgrounds are disproportionately affected by testing because they have increased stressors and barriers that they encounter in comparison to their peers from high-income backgrounds (Cotner & Ballen, 2017; Jensen, 2009). Testing was found to be another barrier of entry to STEM for many students from low-income backgrounds due to a preexisting performance gap that results in low GPAs (Cotner & Ballen, 2017; Sherman et al., 2015). When testing is the only metric for examining STEM readiness and entry into STEM careers, students from low-income backgrounds are at a significant disadvantage, because these communities are historically at-risk in academic achievement when testing is the primary metric (Reardon, 2013). Schools assess academic achievement by testing students, which disproportionately affects students from low-income backgrounds. According to Reardon (2013), factors that play a role in overall academic achievement are GPA, graduation rate, college enrollment percentages, and standardized tests. All these factors are objective means of measurement, often found within the School Accountability Report Card (SARC) as a percentage or number. The SARC was implemented by the California Department of Education to serve as a school report card for increasing access to school data and progress towards meeting yearly school goals (California

Department of Education, 2021). However, when the statistics are examined beneath the surface, significant factors that students from low-income backgrounds encounter as a result of poverty are increased rates of separation from siblings or family, concerns for food or housing, a limited number of toys and books in their childhood, and additional situational challenges that need to be overcome (Johnson et al., 2016; Johnson, Riis, & Noble, 2009). The statistics within the SARC are indicators of academic achievement but are not indicators of which students encounter additional barriers that can not be tested (Reardon, 2013). Testing is a barrier to STEM for students from low-income backgrounds when this metric is the primary means of determining which students can or can not enter STEM careers because it favors those from high-income backgrounds (Soares, 2015).

Additionally, testing affects student motivation in STEM careers by acting as a barrier because many colleges utilize testing through the ACT and SAT as indicators for college fit. Soares (2015) found that one of the strongest factors in income inequality among college admissions was a student's test score. When test scores were used as an admissions metric, 72% of students admitted to a North Carolina university were within the top quartile of the national income distribution. Additionally, at that same university, only 12% of the overall student population were from the bottom 50% of the national income distribution (Soares, 2015). When testing is utilized as an admissions standard, students from low-income backgrounds are disproportionately affected and are significantly less likely to be accepted. While 36% of overall jobs in the United States require postsecondary education, over 99% of STEM employment require at least some postsecondary education (Fayer, Lacey, & Watson, 2017). Standardized testing significantly prevents students from low-income backgrounds from being accepted to most 4-year universities and works as a barrier to STEM, where nearly every job requires some form of postsecondary education (Fayer, Lacey, & Watson, 2017; Soares, 2015).

Lastly, Rozek, Ramirez, Fine, and Beilock (2019) found that the students they studied from low-income backgrounds experienced stress and anxiety from high-stakes exams within their STEM courses. This led these students to perform poorly on these exams and the exams became a barrier in their ability to advance in their STEM education. The impacts of this led to a higher attrition rate among students in STEM. Similarly, Chen (2015) discussed that because of this same phenomenon of testing leading to decreased motivation to either pursue a career in STEM or remain in a STEM major, it leads to higher race and income inequality within STEM professions. The motivation behind both Beilock and Chen's studies was that they both observed high attrition rates among STEM students and STEM professionals among underrepresented students from low-income backgrounds. They both arrived at a similar conclusion that testing was a barrier towards STEM motivation (Beilock, 2019; Chen, 2015).

Improving Testing for Low-Income Students

There are several ways to mitigate testing as a barrier to STEM for students from low socioeconomic backgrounds. Rozek et al. (2019) elaborated beyond the findings of Beilock (2019) and Chen (2015) by also observing what strategies could be implemented to address testing as a barrier for students from low-income backgrounds. They found that when students were able to emotionally regulate their worries and have space to assess their emotional state prior to taking high-stakes exams in their STEM courses, they were able to score significantly higher than when they did not have that space. The number of low-income students that failed their STEM courses in the end after the implementation of emotional regulation practices was reduced by 50% (Rozek et al., 2019). This supported the findings of several studies that students from low-income backgrounds faced external challenges that were barriers towards their academic achievement and, when paired with testing as the metric for measuring STEM readiness, increased the number of barriers that these students faced (Johnson et al., 2016; Johnson, Riis, & Noble, 2009; Rozek et al., 2019; Soares, 2015). Without an understanding of how testing could be improved and accounting for the unique challenges that students from low-income environments face, testing not only becomes a barrier, but also negatively influences future achievement-related choices, such as choosing a STEM career, because of the long-term effect that this metric has on self-efficacy (Eccles & Wigfield, 1983; Mattern, Radunzel, & Westrick, 2015; Vroom, 1964).

Self-Efficacy's Influence on Achievement-Related Choices

Testing not only is a barrier to STEM for students from low-income backgrounds, but also influences achievement-related choices (Eccles & Wigfield, 1983; Rozek et al., 2019). Achievement-related choices were found to be one of the determining factors in student perception of expected outcome and value in pursuing a career. When testing is utilized as a primary means of determining academic achievement, it disproportionately affects students from low-income backgrounds as a result of external factors that contribute to lower test scores (Beilock, 2019). Wigfield and Eccles' (2000) elaboration of expectancy-value theory highlights that a person's value of a decision is based upon their beliefs, past or current personal experiences, and achievement. These values are influenced by self-efficacy and belief of whether they were able to succeed in a given task (Vroom, 1964). In one study, the implementation of testing as a measure of academic achievement influenced the perception of the value of pursuing STEM for students from low-income backgrounds because they were more likely to score lower than their peers from high-income backgrounds (Johnson et al., 2016).

When external factors were not considered within testing, it resulted in a decrease in students' value of choosing a STEM career (Rozek et al., 2019; Wigfield & Eccles, 2000). As student self-efficacy and belief that they could succeed decreases, student motivation and work ethic also decrease in the process. It is critical to understand how testing affects self-efficacy and how self-efficacy influences student desire to pursue STEM.

It is also important to understand how testing affects self-efficacy and how self-efficacy influences student desire to pursue STEM, as self-efficacy is a key factor in understanding student perception of expected outcome and value to pursue a STEM career. Kitchen et al. (2018) found that student perceptions of STEM were more positive among students that had a chance to explore STEM through informal learning environments, like summer intensives and specific programs. Increasing self-efficacy through informal learning environments was effective at also increasing student desire to pursue STEM careers (Kitchen et al., 2018; Roberts et al., 2018). Unfortunately, students from low-income backgrounds are less likely to have access to informal learning, and as a result, are less likely to have high self-efficacy. Informal STEM learning environments increase exposure to STEM careers, an area students from low-income backgrounds are less likely to have knowledge about in comparison to their peers from more affluent communities. The integration of STEM education within informal learning environments has been found to be an integral part of cultivating passion and knowledge in their formal STEM learning environments, which students from low-income backgrounds have been less likely to experience (Bryan et al., 2015; Johri & Olds, 2014; Lucas et al., 2014; Purzer et al., 2014). In addition, Blotnicky et al. (2018) supported the findings of Kitchen et al. (2018) by finding that students with more exposure to STEM content and careers are more likely to score higher on exams than their peers with less exposure. Students from low-income backgrounds that have higher self-efficacy due to increased access to informal learning environments and resources to support academic achievement in STEM are more likely to make achievement-related choices towards STEM careers (Blotnicky et al., 2018; Kitchen et al., 2018; Roberts et al., 2018).

Other informal learning environments that influence student achievement-related choices as a result of increased self-efficacy are paid internships, co-op, and real-world work engagements. Ceyhan et al. (2019) stated students that were more experienced in STEM beyond formal school settings were more like to have higher self-efficacy. Not only did this influence their students' desires to pursue a STEM career, but when tracked into their careers, it resulted in an increased likelihood of remaining in the profession (Ceyhan, 2019; Raelin et al., 2015). Experiences that increased student self-efficacy led to more beneficial long-term achievement-related choices well into their careers.

These findings were further reaffirmed by Maiorca et al. (2021) with their research on informal STEM learning environments and career aspirations of school students. The primary factor that influenced their middle schoolers' desires to pursue a career in STEM was their belief that they would be able to succeed in these careers. Additionally, self-efficacy was a key indicator in predicting academic achievement within STEM and across all other academic areas and grade levels in this study. This emphasizes the importance of developing the self-efficacy of students that come from low-income backgrounds (Maiorca et al., 2021; Usher & Pajares, 2008). Although there is a large emphasis on understanding the impacts of self-efficacy on achievement-related choices, like pursuing a career in STEM, research still lacks a narrowed focus on students from low-income backgrounds. Roberts et al. (2018), Kitchen et al. (2018), and Maiorca et al. (2021) share the commonality that their research was primarily targeted towards a general student population, while simultaneously looking at a small subset of students from low socioeconomic backgrounds. The students from low socioeconomic backgrounds experienced different challenges that students from more affluent communities did not experience, like an increased likelihood for familial and external challenges outside of school (Johnson, Riis, & Noble, 2009; McKenzie, 2019). Further research into how students from low socioeconomic backgrounds are impacted directly and what specific factors within their experiences contribute to this would supplement the existing research.

Perception and Student Desire to Pursue STEM

In addition to the impact of access to informal learning environments on STEM self-efficacy and achievement-related choices to pursue these careers, perception also plays a key role in determining how heavily students desire to enter STEM careers. Student desire to pursue a career is influenced by the expectancy of whether they believed that the goal could be attained and the value of the action (Eccles & Wigfield, 2002). Previous experiences in STEM shape their self-efficacy and belief of competency. In one study, students from low-income backgrounds were less likely to enter STEM careers due to negative perception of STEM programs, because of the dominant belief that science programs were significantly more difficult than non-STEM programs (Cheryan, Master, & Meltzoff, 2015). These students were also more likely to have lower self-efficacy as a result of external stressors beyond school and low test scores that were associated with academic achievement (Henry et al., 2021; Pascarella & Terenzini, 1991; Sithole et al., 2017; Snibble & Markus, 2005). Low self-efficacy decreases student beliefs that their goal of pursuing a STEM career could be attained, devaluing the action of pursuing a STEM major that is perceived as more difficult. Sithole et al. (2017) found that addressing the barrier of negative perceptions of STEM by building student self-efficacy increased the number of students from low-income backgrounds pursuing STEM careers. Improving self-efficacy is a critical factor in guiding students to believe that they can be successful entering STEM and that the expected outcome will be positive. By improving self-efficacy and leading students to believe that there would be a positive expected outcome, this would also positively influence achievement-related decisions for students from low-income backgrounds (Kitchen et al., 2018; Roberts et al., 2018).

Social Factors Contributing to the Disparity

In addition to academic factors like testing and self-efficacy impacting career choice among students from low-income backgrounds, social factors that include limited exposure to role models, absence of representation within STEM, and language barriers also contribute to the increasing disparity in decisions to pursue a career in STEM (Odgers, 2015; Singh & Singh, 2008). Students from low-income backgrounds and affluent backgrounds may be living within a few miles of separation from one another or even within integrated communities, however despite sharing a zip code, they often have experiences that drastically differ from one another (Singh & Singh, 2008). Students that grow up in low-income families are at increased risk for antisocial behavior, unhealthy lifestyles and physical health, and mental illnesses, such as depression (Odgers, 2015). The life trajectory of a student is highly influenced by the resources that the students have when they're growing up and, as a result of poverty, students from low socioeconomic backgrounds grow up with often much less resources than their counterparts from more affluent families (Leventhal & Brooks-Gunn, 2000; Marmot et al., 2008). These social factors are not only important to study and understand in the academic, social, and personal development of a student, but also in the increasing disparity among students from low-income and affluent backgrounds that choose to pursue a career in STEM (Odgers, 2015).

In addition, social factors are heavily influenced by communities in the form of stereotypes and negative expectations. When individuals experience negative stereotypes or perceptions from others, they are more likely to display indicators of anxiety, negative performance gains, and even more likely to give up on the task. Competence based on personal identity is key to the success of an individual (Chemers & Murphy, 1995). Among some minority and non-minority students that grew up in the same community, the impact of perception and stereotypes still impacted the self-efficacy of minority students in a negative way. Communities that had a negative perception of students from minority communities were likely to have low-self efficacy and self-competency levels, according to several studies (Chemers & Murphy, 1995; Chemers et al., 2011; Syed et al., 2011). Students' competency and self-efficacy were highly influenced by whether they believed that they were represented within the career that they were likely to enter. As a result STEM, underrepresentation, followed by the increased negative perception of these students within STEM, resulted in a decreased likelihood that they would choose these careers. Chemers & Murphy (2011) included a large research focus on the impact of stereotypes and representation for students that were underrepresented; gaps that existed were the research focus, examining students from low-income communities. By also conducting future research on students from low-income communities, a greater understanding of the impact of representation as a barrier would allow for targeted interventions to address the issue. The factors and barriers that contribute to the disparity and are discussed in the following sections include limited exposure to role models, absence of presence of representation within STEM, and language barriers as a barrier to STEM.

Limited Exposure to Role Models

The achievement gap between students from low-income and high-income backgrounds is not only increasing based on exams, but also within student exposure to role models in STEM. Students from low-income backgrounds are less likely to enter STEM careers because they have limited exposure to individuals in STEM careers. This often results in these students seeing themselves as individuals that do not belong in these jobs (Wang, 2013). Wang (2013) found that a large impact on student desire to pursue a career in STEM was exposure to math and science courses in the K-12 years, STEM professionals within their local community and family, and overall self-efficacy. Exposure to STEM within a student's upbringing is a predictor of self-efficacy and their future probability of entering these careers. Blotnicky et al. (2018) assessed the correlation between STEM career exposure and mathematics self-efficacy. They found that students with a greater amount of exposure to STEM careers were more likely to have a higher mathematics self-efficacy than students that did not have high exposure to STEM careers. Additionally, students with low-self efficacy had less interest in STEM in comparison to their peers (Blotnicky et al., 2018). Exposure to STEM careers was found to be an essential and integral component in self-efficacy among the students. Wang (2013) and Blotnicky et al. (2018) found that a decrease in exposure in STEM impacted student self-efficacy, which influenced their determiniation to pursue these careers.

Orozco (2019) suggested that an option to effectively support students from low-income backgrounds to enter careers in STEM would be to implement STEM programs with increased community involvement. By increasing community involvement, students from low-income backgrounds would have increased exposure to STEM and ultimately, increased desire to pursue STEM careers (Orozco, 2019). Kricorian et al. (2020) supported the assertions from Orozco (2019) in their study on the impact of representation among underrepresented communities.

They found that among forty-eight adults pursuing STEM careers, many of the students either knew of someone or had a direct role-model within STEM. Inclusive learning through community engagement for students from low-income backgrounds had profound effects on improving likelihood of entering STEM through increasing representation and belief that they belong in these fields (Kricorian et al., 2020).

Furthermore, in a study that examined informal learning environments and the impact of interests on STEM careers, it was revealed that one of the driving reasons why students wanted to enter a STEM career was because they knew someone in the career that served as a role model and motivating factor towards their career aspirations (Maiorca et al., 2021). Additionally, students who did not have a direct role model had another primary motivating factor that influenced them into the STEM career. The second primary reason was that they wanted to help someone, perhaps a family member with an illness or disability, through their work as a STEM professional. Community involvement, exposure to STEM through role models, and social influence have a strong influence on student desire to pursue a career in STEM (Orozco, 2019; Kricorian et al., 2020; Maiorca et al., 2021). Microsoft (2011) surveyed students and asked them specifically what got them interested in STEM and found that the top categories were a teacher or mentor, parent or guardian, or famous person in the field. While toys, games, science fairs, and other extracurricular STEM activities were also included on the list, most of the research indicated that a role model was integral towards integration in STEM. The importance of a direct role model was highlighted within the observation even further when they found that because males were more likely to have a role model, they were more likely to also enter STEM, which was later reinforced within the findings by Maiorca et al. (2021).

Underrepresentation Within STEM

In addition to limited exposure to role models contributing to decreasing academic self-efficacy, students from low-income backgrounds are less likely to be exposed to STEM programs and have less access to extracurricular activities than their peers from more affluent backgrounds. Cooper and Berry (2020) found that the challenge for schools was not only getting students from low-income backgrounds into STEM careers, but that when they were in these careers, there was underrepresentation within the curriculum. Students from low-income families often start school with less experience and content knowledge than students that come from more affluent communities (Ferguson, Bovaird, & Mueller, 2007). As a result, they have less experience outside of school and do not have the same prior knowledge as their peers. Within the classroom, this results in a decreased sense of belonging in STEM, because the curriculum integrates the experiences and backgrounds of students from more affluent communities (Cooper & Berry, 2020). The underrepresentation in curriculum highlights the issue that even when students from low-income backgrounds do choose to pursue STEM careers, they still encounter barriers that their peers do not face.

Furthermore, when examining representation in schools that focused specifically on increasing representation within STEM, the impact of underrepresentation was even more evident (Means et al., 2021). One study found that there were positive effects overall when students attended an inclusive STEM high school and that students were more likely to participate (Means et al., 2021). More notably, the researchers found that for students who came from low-income backgrounds, underrepresented minorities, and female students, there were even greater positive impacts when they attended an inclusive high school. Within these students, the researchers found that they expressed more strong attitudes in math and science and were more likely to attend a college with the intent of pursuing a STEM career than when they were not in an inclusive STEM high school (Means et al., 2021). Specialized STEM high schools intentionally focused on increasing self-efficacy through increased exposure to STEM careers and programs, while encouraging students to believe that they belonged in those careers (Blotnicky, Franz-Odendaal, French, & Joy, 2018; Means et al., 2021). Continual exposure and content knowledge of STEM from students allowed for an increased likelihood that they would choose a career in STEM, which these specialized STEM high schools provided. While Ferguson et al. (2017) found that students from underrepresented backgrounds were less likely to enter STEM, Means et al. (2021) found that the impacts of underrepresentation could be addressed by building an environment where they belonged.

Although Cooper and Berry (2020) highlighted the impact of underrepresentation within STEM courses on student desire to pursue a career in STEM, Means et al. (2021) supplemented this by investigating the benefit for students attending an inclusive STEM high school and its impact on STEM decisions. In addition, Young et al. (2011) found that when students attended a specialized STEM school that highlighted inclusiveness and targeted getting students into STEM careers, students had higher math and science test scores when compared to a traditional public school. At the same time, test scores were an effective means of assessing effectiveness of inclusive STEM schools, but still were not definitive predictors of students' retention in STEM majors even if they chose it initially (Wang, 2013).

Language as a Barrier to STEM

Student language barriers are a critical component studied by researchers as factors that negatively impact student motivation in STEM careers. Neuman et al. (2017) found a significant difference in language level between students from low-income neighborhoods and more affluent neighborhoods. They found that the students from low-income backgrounds were more likely to use shorter sentences, less expansive vocabulary, and had a lower level of understanding of text analysis than their peers. Shanahan et al. (2008) stated that the interactions within the classroom with peers and the opportunity for kids to have lessons rich in reading, writing, and speaking are vital towards their development of language proficiency. On the surface, the language proficiency gap between students from low-income communities and their peers from high-income communities is an issue that may seem to be unrelated to STEM motivation. When this barrier was explored further in certain studies, language proficiency was an important factor towards STEM motivation because of its impact on teaching and learning (Neuman et al., 2017; Shanahan et al., 2018).

While STEM may be seemingly disconnected from humanities, these subjects play a critical role in the success of the future STEM professionals. Language proficiency and language acquisition are critical towards content standards. Content standards could not have been developed without the consideration of language proficiency standards at the forefront of the planning, specifically within STEM education (NASEM, 2018). From the foundation of STEM content standards, language proficiency and acquisition standards work as the base. Students from low-income backgrounds are less likely to have strong literacy and reading comprehension skills than their peers, and as a result, are working at a disadvantage in not only their reading and writing standards, but also their STEM standards (NASEM, 2018; Neuman et al., 2017).

Language content and strategies within STEM are critical in increasing the number of students in STEM careers from low socioeconomic backgrounds. Even though this aligns closely with English, engaging students in building their literacy and language proficiency differs in teaching practices. In STEM, the focus of language and learning emphasizes the functional role of language, rather than the structural elements of language (Grapin et al., 2019). STEM education frameworks focus less on facts and more on engaging students in critical thinking, science and engineering practices, and explaining phenomena (Krajcik et al., 2014). Students from low-income backgrounds are more likely to have a lower language proficiency and, given that the primary goal of the science curriculum is to engage learners in utilizing language to explain STEM, the gap in English proficiency is not only a major gap within humanities, but also STEM (Grapin et al., 2019; Krajcik et al., 2014; NASEM, 2018).

English Language Learner as a Barrier to STEM

Similar to the findings that students from low-income backgrounds are less likely to be language proficient and understand the content, resulting in lower academic achievement and STEM motivation, it was also found that a majority of English language learners also come from low-income backgrounds. Of students that were classified as English language learners, over 60% of those students were from low-income backgrounds (Grantmakers in Education, 2013). This highlights the importance of not only focusing efforts on addressing STEM motivation barriers for students from low-income backgrounds, but also those that are English language learners because they share the same barriers as well, resulting in a lower likelihood that they will enter STEM. Researchers found that the number of ELLs are continuing to increase at a rate that outpaces other sub-groups when looking at K-12 schools (Landivar, 2013; OELA, 2011). Critical instructional shifts need to be made in order to engage ELLs, particularly those that also come from low-income backgrounds, in STEM content in a way that they can understand and participate in (Grapin et al., 2019; Landivar, 2013).

As English language learners struggle to grasp STEM concepts, these barriers result in a decreased sense of belonging in STEM and a decreased likelihood that these students will enter

STEM careers (Lacosse et al., 2020). DePaoli et al. (2015) shared similar findings in a study that found English language learners were severely underrepresented within STEM careers. Most English language learners also come from low-income backgrounds, which also reflects in the statistics of underrepresentation of low-income students in STEM (Grantmakers in Education, 2013). When instructional practices were shifted to focus on social belonging within STEM for English language learners by increasing integration of identity and culture of the students within curriculum, student motivation to pursue STEM increased significantly (Lacosse et al., 2020). This was affirmed by Maiorca et al. (2021) and Kitchen et al. (2018), when they studied the effects of self-efficacy intervention strategies by increasing inclusionary practices in classrooms through community engagement and saw increased motivation in STEM careers. English language learners, and those also from low-income backgrounds, often struggle with a sense of belonging in their courses. By addressing belonging, aligning the curriculum more closely to student needs, students are more likely to be motivated to pursue STEM careers and have this barrier addressed (Kitchen et al., 2018; Lacosse et al., 2020; Maiorca et al., 2021).

STEM Retention

While previous sections explored student motivation to pursue STEM careers, it is also critical to understand how student motivation persists into these careers by studying retention. Students that grow up in poverty and students from affluent communities have different resources available despite living in the same geographic location (Wang, 2013). Blotnicky et al. (2018) and a few other studies found that low-income students experience barriers prior to choosing STEM careers as a result of inequitable testing, language barriers, and underrepresentation within STEM (Blotnicky et al., 2018; Shanahan et al., 2008; Wang, 2013). Despite choosing a STEM major, students from low-income backgrounds experience more barriers that result in being more likely to change their majors or even drop out of college (Chen & Soldner, 2014). Self-efficacy also plays a role in STEM career retention and the themes that are found with students pursuing a career in STEM remain after students commit to these majors. The following sections explore factors that contribute to low STEM retention among students from low-income backgrounds.

STEM Retention Among Students from Low-Income Backgrounds

When students from low-income backgrounds do end up choosing to enter STEM careers, they encounter barriers that result in an increased likelihood that they will change majors or drop out of college (Chen & Soldner, 2014). In addition to current research which indicates that students from low socioeconomic backgrounds are more likely to drop out of STEM, Chen and Soldner (2014) found that males pursuing STEM bachelor's degrees are more likely to leave STEM than females. STEM attrition includes multiple types of scenarios that increase understanding of male and female attrition. Male students are more likely to drop out of STEM and pursue another major, while women are more likely to drop out of STEM by dropping out of college (Nora & Taggart, 2009). Vincent-Ruz and Shun (2018) and Vongkulluksn et al. (2018) highlighted that a key identified need of the education system to engage learners in STEM and retain them in these careers is to foster a positive STEM identity. Additionally, students are more likely to drop out of STEM majors if they feel that they do not belong in these majors. On the contrary, students who express that they belong in their STEM major are more likely to be successful in STEM careers (Rainey et al., 2018). Students not feeling they belong in STEM disciplines increases the likelihood that they will drop out even if they do choose to pursue this major in college, highlighting the importance and the need for further research on what motivations and barriers exist in students from low-income backgrounds(Nora & Taggart, 2009;

Rainey et al., 2018; Vincent-Ruz & Shun, 2018; Vongkullnksn et al., 2018). These findings coincide with other research that identifies the factors of first-generation college students, underrepresented minorities, and individuals from low-income backgrounds as contributing to low retention and high attrition rates in STEM fields (Chen & Soldner, 2014; Hill, Corbett, & Rose, 2010; Shaw & Barbutti, 2010).

Not only is understanding STEM motivation among students from low socioeconomic backgrounds important, but it is also important to understand whether those that choose STEM remain in STEM. Nora and Taggart (2009) and Barr et al. (2008) found that students who initially entered STEM careers encountered gatekeeper courses that were intended to weed out students with weaker academic backgrounds. As a result, when they did not pass or had difficulty in these courses, they were required to either remediate, leave the major, or even risk dropping out of college. Weaker academic backgrounds were a predictor of STEM attrition in several studies, often found in students from low socioeconomic backgrounds as a result of increased external factors (Astin & Astin, 1992; Chen, 2015; Deming & Noray, 2018; Diekman & Benson-Greenwald, 2018). The following section explores these external academic factors that influence retention in STEM.

Academic Factors that Influence Retention in STEM

While it is important for researchers to understand the barriers that prevent students from entering STEM majors, it is equally important for researchers to study what academic factors influence student retention in STEM after they make the decision to pursue these careers (Ceyhan et al., 2019; Dika & D’Amico, 2015). For students from low-income backgrounds, prior research indicated that there were more significant barriers for these students than their peers in their desire to enter STEM careers. Students in one study that did enter a career in STEM faced significant barriers and it was found that they were more likely than their peers to change majors to non-STEM majors (Dika & D'Amico, 2015).

Ceyhan et al. (2019) studied how academic, social, and professional interventions supported undergraduate students pursuing a major in STEM with the goal of decreasing the percentage of students that drop out of these majors; this study provided implications for students from low-income backgrounds. Of all the students that chose a major in STEM at the beginning of their college career, only half graduated within STEM, while the rest chose careers in non-STEM fields (Chen, 2015; National Science Board, 2012; Soldner et al., 2012). When these students were provided with early exposure to careers in STEM, industry connections, and opportunities to engage in the content beyond the classroom, they were less likely to drop out than their peers that did not have early real-world exposure (Ceyhan et al., 2019; Rennie et al., 2012; Shaughnessy, 2013). Similar to Ceyhan et al. (2019), other studies found that at the high school level, students who were exposed to increased informal STEM learning environments were more likely to have high self-efficacy and pursue a career in STEM (Kitchen et al., 2018; Roberts et al., 2018). Beyond having a large influence in initial student desire to pursue a career in STEM, continued exposure to learning environments beyond the classroom with more real-world exposure allowed such students to retain their desire to remain in STEM (Ceyhan et al., 2019; Kitchen et al., 2018; Roberts et al., 2018).

Moreover, students from affluent backgrounds are more likely to have continued exposure to learning environments beyond the classroom, and as a result, are less likely to require intervention strategies to increase retention in STEM careers (Thayer, 2000). Wharton (2019) found that students who are from disadvantaged backgrounds, which includes students that are minorities and students from low socioeconomic backgrounds, are more likely to benefit from STEM science fairs in building their self-efficacy than their peers from affluent backgrounds. The impact of informal learning environments on student decision to pursue a STEM career is stronger among such students than among students from affluent backgrounds because they were more likely to have experiences beyond school (Burke, 2019; Wharton, 2019). Students from low-income backgrounds are more likely to need interventions and support programs that build their self-efficacy in order to build their belief that they can succeed in STEM and, as a result, have a higher retention rate.

Academic Self-Efficacy

Self-efficacy among students from low socioeconomic and affluent communities also displays significant differences, with students from low socioeconomic backgrounds struggling to believe that they are able to succeed in STEM even after they've chosen to enter these careers. This was identified to be a result of a multitude of factors, with one being institutionalized barriers that prevent students from low socioeconomic backgrounds from building their self-efficacy as a result of placement in remedial classes at a young age. Students from low socioeconomic backgrounds are more likely to be placed in remedial classes as a result of being tracked, which includes a disproportionate amount of students from these backgrounds compared to affluent backgrounds, linking intelligence and competency to class level (Ansalone, 2003; Gilbert & Yerrick, 2001; Oakes, 1990). For students that do need support classes in comparison to their peers, the integration of mitigation plans and strategies to address the effects on self-efficacy is critical towards engaging students in STEM and building their self-efficacy. With decreased access to high level math classes, they are also less likely to have access to Advanced Placement (AP) classes and, as a result, are less likely to graduate with the courses required to succeed in STEM (Godwin et al., 2016). Unsurprisingly, as students from low-income backgrounds are placed in remedial courses at a rate higher than students from affluent backgrounds, they are also less likely to graduate with high self-efficacy and belief that they can succeed when current socio-cultural norms link course level with intelligence and competency (U.S. Department of Education, 2016). Addressing self-efficacy through informal learning environments results in lower STEM attrition and is an important academic intervention focus for low-income students.

In addition, students with higher self-efficacy, because of increased exposure to STEM through informal learning environments and role-models, are more likely to pursue STEM. Boelter et al. (2015) focused on self-efficacy, specifically in science exposure with specific programs implemented. The program was a two-year intervention program to introduce students to biomedical and health sciences. They found that students expressed more positive attitudes towards STEM than their peers that did not participate in this program because of their increased exposure to the science intensive. By building their confidence through continual exposure, they were able to conclude that this was an effective measure at building student self-efficacy and motivating students to choose STEM careers when they statistically came from a background that made them less likely to enter STEM careers (Boelter et al., 2015). This coincided and aligned with the findings by Orozco (2019) and Kricorian et al. (2020), highlighting the importance of self-efficacy in student decision to pursue STEM.

Summary

As a result of current research, it is understood that students from low socioeconomic backgrounds are less likely to pursue a career in STEM because they experience increased stressors that students from affluent communities do not face, have lower self-efficacy, and do not have exposure to role models that are able to be motivators towards these careers (Chen, 2015; Deming & Noray, 2018; Diekman & Benson-Greenwald, 2018). Additionally, these factors were not only identified as factors that exist among students from these communities in comparison to more affluent communities, but also as factors that were positive predictors of success and motivation in STEM. Research had been conducted that assessed the impact of varying instructional and program changes on student desire to pursue a career in STEM, with many concluding that students from low-income backgrounds benefitted from increased informal STEM learning experiences, instructional changes to build self-efficacy, and inclusion of more role models through community outreach in the curriculum (Backes et al., 2018; Kitchen et al., 2018; Roberts et al., 2018; Young et al., 2011). Other researchers have summarized key barriers, such as testing, environmental influences, and differences in upbringing among students from low socioeconomic and high socioeconomic backgrounds (Han, Kelley, & Knowles, 2021; Martin-Hansen, 2018; Roberts et al., 2018; Stout et al., 2011). Despite this, what is still currently not known is what specific factors motivate students to pursue a STEM career within the classroom. Additionally, how students from low-income backgrounds perceive learning within the classroom and its influence on their motivation to pursue a career in STEM remains a gap in the literature. This study sought to address how students from low-income backgrounds perceive learning within the classroom and its effect on their motivation to pursue a STEM career from an expectancy-value theory theoretical framework.

CHAPTER THREE: METHODS

Overview

The purpose of this transcendental phenomenological study was to describe the experiences of students from low socioeconomic backgrounds that intended to pursue a career in STEM at Science High School. This chapter explores the qualitative design of the study, participants, data analysis, trustworthiness, and provides a foundation for the present research study. The philosophical assumptions are explored and each of the assumptions (ontological, epistemological, axiological) are described. Additionally, the setting and participants of the study are included with context on the lived experiences of students from low-income backgrounds that are pursuing a STEM career.

Research Design

The purpose of this study was to examine the lived experiences of students from low-income backgrounds and their motivations towards pursuing a career in STEM. A qualitative research method was chosen because of the focus on observational analysis through observation, description, and explanation of an observed phenomenon (Aspers & Corte, 2019; Gerrish & Lacey, 2010). Additionally, qualitative research methods emphasize the importance of understanding a phenomenon at a deeper level. This research study was determined to be best suited for a qualitative research method because the purpose of the study focused on the identification of factors through observation, description, and explanation. In addition, qualitative research design is a broad approach that includes many subsets or types of designs. A phenomenological study was believed to be the most appropriate choice for the study because it focuses on identifying the shared experiences of individuals within the same phenomenon (Creswell & Poth, 2018). A transcendental phenomenological qualitative research design was determined to be best suited for the purposes of the study because of the importance of the identification of intentional meanings as a way of describing a phenomenon. Ultimately, the chosen research approach allowed the researcher to determine meaning by understanding the lived experiences of the participants themselves rather than through numerical data and statistical analyses (Allywood, 2011).

Furthermore, a transcendental phenomenological approach was chosen as the research method because of the focus on seeking to understand the lived experiences of students and their desire to pursue STEM careers (Creswell, 2013; Moustakas, 1994). Creswell (2013) supplemented this by emphasizing that transcendental phenomenological studies are descriptive and pure in nature. Due to the nature of the research interest, this researcher decided that a transcendental phenomenological qualitative study design would be the most appropriate. The goal was to describe factors that motivated students to pursue STEM careers among students from low socioeconomic communities. This fit more with a transcendental phenomenological study than a hermeneutical phenological study because it focused on describing the lived experiences of the participants, through observation, description, and explanation of the phenomena (Aspers & Corte, 2019; Creswell & Poth, 2018). By understanding the factors that influence students from low socioeconomic backgrounds and their desire to pursue a STEM career, researchers can better understand the overall human experience and determine best practices towards increased equity within the classroom (Moustakas, 1994). The study sought to expand into Moustakas' (1994) definition of phenomena by expanding beyond the statistic that students from low-income backgrounds were less likely to enter STEM and towards understanding the experience of why these statistics existed and were maintained.

Research Questions

The following section explores the research questions that were key components for this study.

Central Research Question

What are the experiences of students from low socioeconomic backgrounds pursuing a career in STEM?

Sub Question One:

How does academic self-efficacy in students from low-income backgrounds affect their perceptions of the expected outcome and value of pursuing a career in STEM?

Sub Question Two:

How do students perceive classroom interventions to affect their expectancy and value of pursuing a career in STEM?

Setting and Participants

The setting of the study occurred within a Southern California high school that serves students from primarily low socioeconomic backgrounds. The first section describes the setting, location, and general overview of where the study was conducted. The second section describes the participants within the school that participated in the study to provide a clear depiction of the criteria for participation.

Setting

The setting for this study was a high school in Southern California. The high school is a Title 1 high school, and the district primarily served students from low socioeconomic backgrounds as defined by qualification for the free and reduced lunch program within an area that is estimated to be around 60 square miles. There were 1,500 students, 68 full time teachers, four assistant principals, and one principal at the time of this study. The leadership structure follows district policies of a principal, assistant principals assigned to specific focus areas like discipline and student engagement, department chairs, teachers, and lastly, support professionals. To maintain confidentiality, pseudonyms of Science High School (SHS) and STEM Unified School District (SUSD) are used throughout this dissertation. According to the School Accountability Report Card (SARC) for SHS, 90% of students were socioeconomically disadvantaged at the time of this study. This site was chosen as the location because it serves the primary student population of the proposed study. The study focused on describing the lived experiences of students from low-income backgrounds, and the site primarily had students with low-income backgrounds from a large urban city.

Additionally, the participants were all specifically taking a chemistry course, which allowed for standardization among the participants' course experiences and environment. It was important that the chosen school site had a science curriculum aligned with state and district standards. SHS and SUSD are aligned to the Next Generation Science Standards (NGSS) course model and follow a 3-course model, where students take The Living Earth (integration of biology and earth science), Chemistry in the Earth System, and Physics of the Universe. The organization of the course structure follows the adopted curriculum and schoolwide supports, and interventions are organized by the school site administration with teacher influence. This allowed for the proposed site to be representative of the population and communities.

Participants

This study focused on identifying factors that influenced students from low socioeconomic backgrounds and their desire to pursue a career in STEM, which required a specific sample of participants. A criterion sampling method was identified as the most appropriate for the study. It was important that a sampling method that fit the purposes of the study was chosen because it influences the means by which the study is conducted and can potentially influence the study as well. Criterion sampling focused on the identification of a criteria and determining whether the participants fit the intent of the study (Cohen & Crabtree, 2006).

The ideal population for the study was 50% male and 50% female, between 14-16 years old, with all the students coming from low socioeconomic backgrounds. Each and every participant was not known at the beginning of the study, however as the participants became known, the researcher listed them in Table 1. There were 10 participants within the study that were engaged in a STEM course and fit within the criteria of being from a low socioeconomic background. The criterion for low income was defined by the ability of the participants to qualify for the free and reduced lunch program.

Researcher Positionality

This section describes the interpretive framework, philosophical assumptions (ontological, epistemological, axiological) that guide the study. I grew up in a primarily low socioeconomic community, as well as attended primarily Title 1 schools my entire life. As a result, I have seen my peers who started with a strong desire to pursue STEM careers eventually stop pursuing these careers over time. By describing the experiences of students from low-income backgrounds and seeking to understand the motivations and barriers that prevented or motivated these students from pursuing a career in STEM, greater shifts could be made in education that encourage these students to enter these careers. The primary interpretive framework that drove this research study was social constructivism (Creswell & Poth, 2018). The following section explores this in greater depth.

Interpretive Framework

The interpretive framework that drove this research study was social constructivism. Social constructivism emphasizes learning as collaborative, which shapes its views on knowledge and learning (Vygotsky, 1978). Vygotsky (1978) emphasized that communication through language and the integration of culture within knowledge and learning shapes students' understanding of content and learning. As students engage in active learning, social constructivism highly emphasizes the idea that motivation is a combination of both intrinsic and extrinsic events that shape a learner's desire to continue learning. Social constructivism worked as the interpretive framework for the study, as the study looked to determine the motivation and barriers of students from low socioeconomic backgrounds in their desire to pursue a career in STEM. More specifically, these motivations and barriers are often shaped by extrinsic and intrinsic motivators, which highlight the importance of the interpretive framework of social constructivism in this study (Wang, 2020).

Philosophical Assumptions

Philosophical assumptions describe the assumptions that I brought into the study, whether they were ontological assumptions, epistemological assumptions, or axiological assumptions. Each of these types of assumptions situated the research on my view of the world, how I approached the research, and my positionality on these philosophical assumptions. The ontological assumptions describe my beliefs on the nature of reality. Epistemological assumptions describe what counts as knowledge and how current knowledge on the research both was understood as well as how it was situated within both the research that was conducted and myself as the researcher. Finally, the axiological assumptions below describe the values that I brought to the study that may have served as bias within the study.

Ontological Assumption

Ontological assumptions focus on what the nature of reality is with the characteristics of seeing multiple realities through varying viewpoints (Creswell, 2009). The premise of multiple realities highlights the premise and the purpose of the research study as one that allows for the multiple realities of the participants to be studied and understood. In this research study, the multiple realities acknowledged that the students from low-income backgrounds had a differing reality than those from other backgrounds and, as a result, were a basis for further observation within a transcendental phenomenological study (Neubauer et al., 2019). Ontological assumptions focus on my beliefs in the nature of reality and whether there are single realities (universal realities) or multiple realities. My foundational ontological assumption is set on a singular universal reality that all things, whether visible, not visible, able to be observed, or even not observable, are derived from the God of Christianity and of Christ. Within that focus, the ontological assumption in the study was that progress and desire towards pursuing a career in STEM could be observed and measured. The qualitative observations and understandings of student desire to pursue STEM careers allow for an understanding of how others could also either be encouraged to pursue a STEM career or not pursue a STEM career. The study followed a realistic ontology that presumed there is cause and effect within the world.

Epistemological Assumption

Epistemological assumption addresses what knowledge counts as knowledge, how it is understood and known, as well as how it relates to me and the research (Creswell & Poth, 2018; Crotty, 2003). The definition of an epistemological assumption is one that seeks to understand and explain what is known (Crotty, 2003). The current understanding of student motivation to pursue a career in STEM was obtained from previous research that was measured and understood. This research that was measurable and objective allowed for a baseline understanding of the prior research on what barriers and motivations existed within these students. The results that were obtained within this study are objective and could be utilized as a reliable addition towards the contribution of knowledge on motivations and barriers on STEM education. The epistemological assumption was more subjective than that of a quantitative research method because of the focus is on the experiences of the participants within this study. My epistemological assumption was based on my experiences as a student in Title 1 schools for my K-12 education and experiences as a teacher within a Title 1 school. I had seen the challenges that being from a low-income background had on my peers because of external factors that diverted attention from academics. I valued STEM education and more importantly, equal access to STEM education for all students, regardless of their socioeconomic status. The relationship between myself and what was being studied led me to seek to understand the genuine experiences of the participants. More importantly, it required me to recognize and set aside my current understandings because of my experiences and preconceived prejudices to study the experiences of students pursuing STEM authentically.

Axiological Assumption

Axiological assumptions are defined as the ethical issues that need to be taken into consideration within the research that is being conducted utilizing a philosophical approach of decision making (Finnis, 1980; Kivunja & Kuyini, 2017). The axiological assumptions of this study focused on the values that I brought into the study. Conveying these assumptions allows others to understand the position that the research was based on. I primarily attended Title 1 schools located in low socioeconomic areas. As a result, I was very familiar with the learning environment of the participants within the study. This allowed me to have a unique perspective on what students may have experienced in these environments and allowed me to understand my biases. By developing questions prior to the interview, I could build questions that may lead participants to answer a certain way and avoided leading questions. Alternatively, a researcher without prior knowledge of Title 1 schools and working with students from low socioeconomic backgrounds may encounter challenges in being able to understand the experiences of students and effectively develop common shared themes around the experiences that they may be going through.

Researcher's Role

I am a high school science teacher with five years of teaching experience. Additionally, I am credentialed in biology, chemistry, earth and space science, medical and health technology, information and communication technology, and education, child development, and family services with a diverse understanding of science curriculum. As the human instrument in this study, it was important I ensured that I was putting the participants at the center of the focus by being an observer and documenting notes from them. At the research site, I also had a role as a high school teacher within the site where the participants were students. I did not teach the students at the time that they were participants in the study. Finally, it was critical that I assessed my biases and assumptions that I would bring to the study and how they would influence the data as I conducted my analysis. As a high school science teacher, I have a positive bias towards increased supports and interventions that engage learners towards STEM careers. As a result, I needed to ensure that I was carefully considering my question framing, had observation notes true to the participants, and was being an objective researcher. This was a transcendental phenomenological research method and, as a result, the participants' experiences were the focus rather than my own.

In addition, within the study, I was also the main instrument in alignment with understanding of the premise of qualitative research (Peredaryenko & Krauss, 2013). As the primary instrument of the study, I worked to observe, take notes, interview the participants, and utilize the data to construct themes from the lived experiences of the individuals. As such, I not only was recognized as the researcher, but also as a human instrument within the study (Peredaryenko & Krauss, 2013; Potgieter & Mokomane, 2020; Sloan & Bowe, 2014).

Procedures

After the proposal defense, the procedures for this study were grounded on the importance of obtaining Institutional Review Board (IRB) approval. The importance of this step during the procedures was to ensure the protection of the participants within the study, equity among the selected participants, and weigh the risks to benefits ratio of the study (Creswell & Poth, 2018; Gall, Gall, & Borg, 2010). Afterwards, the next step was to use a criterion sampling method to identify participants, which also sought to ensure that they met the predefined criteria for this study. The participants were chosen within the chemistry course by specifically identifying students that fit with the criterion and ensured that they were actively enrolled. In addition, participants were given consent forms prior to their voluntary participation, which included observations, focus groups, and interviews. These three data collection methods were the primary means that the study used to collect and analyze data. Ten scheduled observations occurred over the course of the research process and occurred over 30 minutes per observation. These varied means of gathering data allowed for data triangulation to ensure reliability of the research and variability in data types, which were also outlined by Moustakas (1994) as guidelines for transcendental phenomenological studies.

Permissions

The first step for obtaining permissions was to obtain permission from the school site where the study was conducted. This began by asking two groups of people. The first were the school site administrators (assistant principal(s) and principal) (Appendix A). Afterwards, district permission was obtained. The second step of permissions was to obtain IRB approval prior to conducting any research on participants, which began after the proposal defense (Appendix B). Upon IRB approval and the approval to move onto the next phases of the research process, individual permissions needed to be obtained from the participants, and if necessary according to school policies, also from the parents or guardians of the participants.

Recruitment Plan

The sample consisted of students from a southern California high school in a low socioeconomic area. The students were all students enrolled in a chemistry course and had previously taken one year of science. The sample size for the research study consisted of 10 students. The number of participants was identified by understanding Yin's (2014) emphasis on ensuring that quality participants were chosen for the research study. The recommended participant count for transcendental phenomenological studies according to Creswell and Creswell (2018) is 3-10 participants. The goal of choosing this many participants is to saturate the data to allow for the participants within the research to be reflective of the varying experiences of the population where the widest range of data can be gathered (Glaser & Strauss, 1967; Saunders et al., 2018). To choose the participants, an email was sent to all chemistry students with a Google Form that asked them for their first name, last name, grade, ethnicity, and family income level. Among five sections of chemistry courses with the same teacher to maintain instructional consistency, the interest form was sent to a total of 174 students. The broad sampling method that occurred for this study was the criterion sampling method, which identified a criterion and utilized the criterion as a means of determining whether participants were fit for the purposes of the study (Cohen & Crabtree, 2006; Creswell, 2007). Purposeful sampling specifically focuses on the selection of participants that are specifically selected for the purpose of understanding the research interest or phenomenon. Within this study, it was important that the participants were enrolled in a STEM course and were from a low socioeconomic background. As a result, purposeful sampling allowed for the purposeful selection of participants that fit the criteria and understood the phenomenon (Cohen & Crabtree, 2006; Creswell, 2007).

More specifically, the type of criterion sampling method was purposeful sampling, which intentionally selected the participants specifically with the intent of describing their experiences, barriers, and motivations associated with these students from low socioeconomic backgrounds with an intent to pursue a career in STEM (Cohen & Crabtree, 2006; Creswell, 2007). Given the nature of the study, it was important that the participants within the study were representative of the population that the research interest intended to understand and described the experiences of a transcendental phenomenological study. After the recruitment survey results were gathered, the data was analyzed and students that qualified for the study were randomly chosen to be among the 10 participants. Informed consent of the 10 participants was obtained prior to data collection (Appendix B).

Data Collection Plan

The primary means of data collection in this study were structured interviews, focus groups, and surveys. The cumulation of the evidence from these three data collection methods was important towards allowing for detailed information from the participants. The focus of transcendental phenomenological research design is on the experiences of others. More specifically, on the experiences of the participants to understand the phenomena, placing increased importance on multiple means of data collection (Moustakas, 1997). Creswell (2013) also emphasizes the importance of data triangulation by including multiple means of collecting data. It adds an extra layer of validity and trustworthiness by having cross-verification of the data from the different sources.

Observations Data Collection Approach

The observation of the experiences of the students was conducted as the first means of gathering information. Ten scheduled observations of the participants were conducted that occurred at 30 minutes per observation. Each student was observed in the same non-honors chemistry course and for the same exact amount of time. During the observation, I was a non-participant observer and did not interact with the students. As students were engaging in their STEM courses, it was important that information was understood regarding how students interact with the content and information within their courses. Detailed notes were taken during this data collection to ensure that the lived experiences of the students were accounted for accurately and reliably. During the observations, data focused on how classroom interventions impacted student response and learning. In addition, the experiences of students and their response to classroom interventions were observed, as well as the overall impact on academic self-efficacy towards pursuing a STEM career. The observation protocol (Appendix B) that was developed focused on observations of positive and negative indicators of academic self-efficacy, as well as classroom interventions and how participants responded to these interventions.

Observations Data Analysis Plan

The specific type of observation that occurred in this study was the complete observer role, where the researcher served as the observer throughout the duration of the observation without any participation role. According to Creswell and Poth (2018), the primary advantage of observations, specifically observations without participation, is that it allows for increased observation of aspects that may not have been noticed if the researcher were to have participated. Additionally, it explores topics through observation that participants do not mention or are not comfortable discussing within the second data collection approach of individual interviews. The observation occurred with an observation protocol, where an observation protocol document was used within each observation. The same observation protocol form (Appendix B) was utilized to allow for consistency across all the observations and allowed for further analysis with comparison between multiple observations afterwards.

Interview Data Collection Approach

Interviews were conducted to obtain a better understanding of students' experiences in STEM and how those experiences included their decisions to pursue STEM careers. Within the process, obstacles and barriers that they encountered were revealed. Table 2 lists the open-ended questions that students were asked within the interview, which dove deeper into their experiences of the phenomena. Tomaszewski, Zarestsky, and Gonzalez (2020) discussed the importance of not only diverse data collection methods within a qualitative design, but also the importance that each research method has a clear and distinct purpose. The intent of interviews within this phenomenological study were to use open-ended research questions to collect information and create a more in-depth understanding of what factors influence student decisions to pursue STEM careers.

Further planning ensured that the interviews were designed for clarity, and purpose was considered before administration to the participants within the study. The first step was to review the questions and ensure that all questions met Moustakas's (1994) interview design criteria of being open-ended questions rather than questions that elicited a yes or no response. Additionally, the questions were semi-structured to allow for follow up questions and clarifying questions during the interview. Then, prior to administration of the interviews with the participants, IRB approval was attained to ensure that the study would be allowed to go through and worked with the participants. Finally, the last step focused on refining the clarity of the questions. This was done by working with students that were not part of the study to test the questions, and feedback was received from students and other educational experts. After revisions, the following questions within Table 2 were used during the interview. The interview occurred virtually to best accommodate the schedule of the participant by using Zoom as the video conferencing platform. The interview was recorded and I transcribed the interview afterwards. I utilized Microsoft Word to upload the .mp3 audio file directly into the software and allowed it to digitally transcribe the recording onto a Word Document. Finally, I went back and listened to the recording while following along with the digital transcription, ensuring accuracy of the transcription.

Table 1

Standardized Open-Ended Interview Questions

Questions
1. Please tell me about yourself and your first experiences in STEM. CRQ
2. How would you describe your academic performance in your science classes? CRQ
3. Describe a positive learning experience in your STEM classes and what made it a positive experience. CRQ
4. What did teachers do that specifically made you feel supported or positively influenced your confidence in learning STEM? SQ1

5. Describe a negative learning experience in your STEM classes and what made it a negative experience? SQ1
6. Describe a role model that you personally know. SQ1
7. What did teachers do that specifically made you feel lack of support or negatively influenced your confidence in learning STEM? SQ1
8. What do you believe are your strengths that would help in a STEM career? SQ1
9. What is your interest level in pursuing a career in STEM? SQ2
10. What do you believe would be the expected outcome if you chose to pursue a career in STEM? SQ2
11. What value do you believe that pursuing a STEM career would or would not have in your life? SQ2
12. How do you believe that your family income, living location, and previous experiences with exposure in STEM influenced your passion to pursue or not pursue these careers? SQ2
13. What suggestions would you give to a school or teacher that would make pursuing a STEM career more appealing for you? SQ2
14. What factors influence your desire to pursue a career in STEM? SQ2
15. Describe a role that your teacher has in your decision to pursue a career in STEM. SQ2

Question 1 opened the interview by asking the students to provide a brief overview of who they were and what experiences they had in STEM courses. This was to help address student comfort in STEM and their experiences. Question 2 asked students to describe their academic performance in their STEM courses. This helped the interviewer understand the individual participants' academic performance and provided a foundation for their subsequent answers.

The purpose of question 3 within Table 2 began to dive deeper into student confidence in their STEM courses. Mattern, Radunzel, and Westrick (2015) found that in the United States, only 26% of students were ready for STEM careers and Roberts et al. (2018) supplemented this by finding that student motivation to pursue STEM careers was related to their confidence in their STEM courses. This question allowed for a deeper understanding of student self-efficacy and provided a greater perspective of the participants in relation to the prior research studies. Questions 4 to 7 expanded into specific participant experiences to determine what steps and factors influenced their experiences in STEM classes both in a positive and negative way. The questions were based on Diekman and Benson-Greenwald's (2018) research that described the impact of student experiences on desire to enter STEM careers and motivation in their STEM courses. These questions helped to provide perspective and better understand experiences of the participants. Question 8 explored role models in the life of the participant if applicable to better understand if there was a role model that supported their desires to enter or not enter STEM. Question 9 explored student interest level in pursuing STEM. Questions 10 to 12 related student motivation, expected outcome, and value of pursuing a STEM career to the theoretical framework of Expectancy-Value theory in order to understand how student motivation was influenced by these two factors (Vroom, 1994). Questions 13 and 14 focused on understanding factors inside and outside of the classroom that positively motived student desire to pursue a career in STEM, for the purposes of understanding the experiences of students and what had not been implemented that they believed would be helpful. Finally, question 15 narrowed the interview back to teacher interventions that were either positive or negative influences towards STEM careers.

Individual Interview Data Analysis Plan

Qualitative interview procedures were followed as the individual interview data analysis plan. Face-to-face interviews were conducted with the participants, and they involved a structured interview process utilizing the questions planned above (Creswell & Poth, 2018). This process allowed the interview process to be a space for the participants to describe the feelings, attitudes, experiences, and background in STEM education. An interview protocol was developed and utilized for asking and recording questions, which occurred both through handwritten notes and audio recordings. These logs allowed for the accurate transcription of the accounts of the participants. I transcribed the individual interview data by typing it on Microsoft Word documents with each individual participant distinguished and timestamps encoded. This was first done digitally through Microsoft Word's digital transcription, and then I listened to the audio and compared it to the transcript to ensure accuracy. Additionally, the interview was sent back to the participant with the audio recording and transcript to incorporate member checks, ensuring credibility and trustworthiness (Creswell & Poth, 2018). Within the transcripts, I was specifically looking for participants' overall lived experiences in their desire to pursue a STEM career; however, all discussions during the interview were transcribed even if it was not related in order to be detailed. Moustakas (1994) emphasized the importance of building a process by which individual interviews could be organized and analyzed into experiences that are coherent and descriptive. The interview was analyzed by identifying commonalities and shared experiences among all participants, which was organized into themes. Audio recording was uploaded in .mp3 format into Microsoft Word's digital transcription. The recording was listened to and crosschecked to verify accuracy of digital transcription and revised by hand coding into themes.

Focus Groups Data Collection Approach

The focus group was chosen as a means of data collection because it allowed for interaction with multiple participants, gathering information that was critical to the research questions. The conversation was centered on students' experiences in STEM, barriers that they believed existed in their mindset of STEM, and factors that impacted student self-efficacy to pursue STEM careers. Focus groups allowed for interviews with students who had similar backgrounds and shared commonalities that could be explored through small group interviews, which fit the design of the study well (Patton, 2015). A total of six participants were randomly chosen for the focus group, taken from Onwuegbuzie et al.'s (2009) emphasis on ensuring the focus group includes an adequate number of participants that allow for diverse perspectives and information gathered, comfortability in communication and discussion, but that is also not so large that it deviates from all students having a shared bond. Additionally, the focus group took place virtually to accommodate the schedules of all the participants by using Zoom. The focus group interview was recorded. The six participants were chosen from the original participants within the overall study to allow for an in-depth understanding of the factors that influenced student desire to pursue STEM careers. The focus group addressed six questions during the conversation that allowed for a greater understanding of the motivating factors to enter STEM careers among students from low socioeconomic backgrounds.

Table 2

Standardized Open-Ended Focus-Group Questions

Questions
1. Please provide an introduction to yourself and about your experience in STEM education. CRQ
2. What do you believe was a moment of disappointment in your STEM classes? SQ1

3. What has helped you feel successful in your STEM classes? SQ1
4. How do your experiences in your STEM classes influence your desire to pursue a career in STEM? SQ1
5. What difficulties or obstacles did you encounter in your STEM classes? SQ2
6. What do you believe was your greatest success in your STEM classes? SQ2

Question 1 asked the participants to introduce who they were and provided a foundation to the focus group questions. It also established a foundation towards understanding their experiences in STEM education. The second question asked the participants what difficulties or obstacles that they perceived to encounter within their STEM classes. Ejiwale (2013) discussed the importance of STEM education and the importance of understanding barriers for successful integration of STEM education. Questions 3 and 4 built off of the research conducted on the importance of identifying barriers in STEM. Question 3 focused on identifying positive experiences of the participants in their STEM courses, while question 4 contrasted by identifying a disappointment that the participant experienced in their classes. Mattern, Radunzel, and Westrick (2015) found that only 26% of students were prepared to enter STEM careers. As a result of the currently low percentage of students who are prepared to enter these careers, question 5 sought to identify what helps students within their courses to be successful, while question 6 tied in the relation of their experiences in their STEM courses with their overall motivation to enter these careers.

Focus Group Data Analysis Plan

Focus group interviews were audiotaped, and then transcribed after the interview was concluded. This followed the guidelines within Creswell and Poth (2018). The data recording followed a data recording procedure, which utilized the observation protocol that was utilized for the individual interview data analysis plan. The procedures of the focus group interviews began by asking the first question, followed by the next five, which allowed for an overall understanding of the beliefs, barriers, and motivations for these students to pursue a STEM career. The focus group differed from the individual interviews in that it was conducted with multiple participants. The intent of including multiple means of interview types as the varied data collection methods was because focus group interviews allow for the opportunity to gain insight on social issues that affected multiple people (Nyumba et al., 2018). Selectively chosen individuals within the focus groups allow for qualitative data that is representative of a population that is broader than data that was obtained from individual interviews (Creswell & Poth, 2018; Nyumba et al., 2018). The data was collected by recording using a MacBook Pro Voice Memos application and then converted to a .mp3 file. After the data was collected, I transcribed the data onto a Word Document. Microsoft Word digitally transcribed the .mp3 file onto a Word Document and then I listened to the interview again, while reading the digital transcription to ensure accuracy. Each individual participant was distinguished and timestamps were included to allow for referencing the lived experiences of students and their desire to pursue a STEM career.

After articulating the data analysis approaches discussed above, the findings were synthesized into a series of themes across the lived experiences of students from low socioeconomic backgrounds that intended to pursue a career in STEM. By highlighting the lived experiences of students, the themes were able to describe and understand what motivations and barriers existed in these students' educational experience. The data was synthesized by looking at the observation data, interview notes, and document analysis (student forms and questionnaires, transcription, SARC data). By seeking to understanding what commonalities could be synthesized into themes, a greater understanding of the barriers and motivations that existed in these students was attained. Each of these was synthesized together, rather than kept as individual data points.

The observations, interviews, and focus groups were transcribed verbatim using Microsoft Word digitally, and then double checked by listening to the interview and reading the transcripts to ensure accuracy. By identifying dominant themes, the lived experiences of the participants was accurately described, and meaning was derived from the participants' experiences (Moustakas, 1994). For every answer, the individual statements were analyzed and given meaning through epoche and horizontalization. Following Moustakas (1994), the themes were further narrowed down through reduction, elimination, and clustering. At the end of the data synthesis, the lived experiences of each participant were analyzed and common themes were summarized.

Data Synthesis

After all the data was collected and analyzed, the data was reviewed and coded into textural and structural descriptions. The textural and structural descriptions worked to describe the lived experiences of the participants from low-income backgrounds pursuing a career in STEM. The experiences of the participants were described within the textural descriptions, while how participants experienced the phenomenon of pursuing STEM were within the structural descriptions (Creswell, 1998; Moustakas, 1994). By including both textural and structural descriptions from the observations, focus group, and semi-structured interview, the essence of the phenomena was captured (Moustakas, 1994).

Trustworthiness

The trustworthiness was determined by assessing credibility, dependability, transferability, and confirmability within the study. Strategies such as triangulation and persistent observation were employed for the study. Credibility ensures for the truth-value within a research study, similar to how quantitative studies have internal validity (Korstjens & Moser, 2018). Dependability and confirmability work to ensure the consistency throughout a qualitative study, and transferability determines the context by which a study can be transferred to other studies (Creswell, 2007). Together, these aspects of trustworthiness worked to ensure accountability within this study.

Credibility

Credibility ensures that there is confidence within the research results and findings by ensuring that the information is correctly interpreted and analyzed (Korstjens & Moser, 2018). It highlights the importance of bracketing out prejudgment within the research findings and the utilization of increased and varied research methods increases credibility within a study (Moustakas, 1994; Korstjens & Moser, 2018). Within this study, credibility was established through continued observation and triangulation. Data triangulation involved collecting evidence from multiple sources, which were through observations, interviews, and focus groups. By having multiple sources of data collection, the lived experiences of the participants and their experience in pursuing STEM were understood on a deeper level and more accurately captured their experiences with credibility (Creswell, 2013). By having multiple means of collecting information, the data gathered provide increased credibility and confidence within the truth of the findings (Patton, 2015). Prolonged observations allow for increased credibility by producing rich data (Korstjens & Moser, 2018). Additionally, credibility was further established through participant checks (Creswell & Poth, 2018). After each interview was recorded and transcribed, the recording and interview were shared with the participant to ensure that the information within the recording and transcription were accurate. Creswell and Poth (2018) highlight the importance of participant checks in ensuring the overall credibility of the study.

Transferability

Transferability is defined as, "The degree to which the results of qualitative research can be transferred to other contexts or settings with other respondents. The researcher facilitates the transferability judgement by a potential user through thick description" (Korstjens & Moser, 2018, p.121). Transferability also focuses on the extent to which the study is applicable within other settings. To ensure transferability, a thick description was provided that included the behavior and experiences of the participants. Context was also highlighted and provided within the thick description and that was important, as the behaviors and experiences of the students as the context helped understand and further clarified meaning. By having clear and specific criterion sampling methods for selection of the participants and detailed descriptions of the setting, this study allowed for increased consistency and transferability (Slevin & Sines, 1999). The criterion for sampling allowed for variation in gender, age, and experience, which increased the overall transferability of this study to another context.

Dependability

Dependability focuses on how stable the findings are over time, with a focus on the interpretation of the findings, evaluation, and future recommendations. Confirmability is the extent to which other researchers are able to confirm the findings within this study. Korstjens and Moser (2018) summarized the two as the consistency of the study. To ensure that this study followed a study with dependability and confirmability, transparency was emphasized within the documentation and accuracy throughout. By ensuring that the research was logical, traceable, and documented, the study was focused on both dependability and confirmability (Patton, 2015). Interviews were recorded, transcribed, and sent back to the participants to review and confirm or edit. The steps and progression within the study were recorded and the steps were followed to ensure that it could be verified by inquiry audit.

Confirmability

Confirmability refers to the degree to which the findings of a study are shaped by the participants within the study, rather than by the bias of the researcher, motivation, or interest (Lincoln & Guba, 1985). Additionally, confirmability is referred to as the degree to which the research is able to be confirmed by other researchers, often due to results shaped by data and not researcher bias (Korstjens & Moser, 2018; Lincoln & Guba, 1985). Confirmability within this study was established through an audit trail and triangulation. Audit trails establish confirmability by providing a trail of both physical and intellectual knowledge from the researcher. It allows the reader and other researchers to understand the thought processes and physical documents that are utilized towards construction of the themes within a study (Carcary, 2009). Triangulation was utilized within this study to establish confirmability by gathering multiple data sources throughout time and utilizing varied types of data collection within the study. The varied types of data collection outlined within the study allowed for triangulation and synthesis of data that was not from a singular instance of data collection (Korstjens & Moser, 2018; Sim & Sharp, 1998). Both audit trails and triangulation work to establish confirmability within the study and ensure that the findings within the study are shaped by the participants (Lincoln & Guba, 1985).

Ethical Considerations

Ethical considerations were important in this study and methods to ensure that the study was conducted ethically were taken into consideration. The participants, school, and identifying markers were given pseudonyms for confidentiality. In addition, the participants voluntarily gave their consent for their involvement and participation in the study, which was collected prior to any data collection. Participants were made aware of the full extent of the study by being informed of the purpose, risks, and benefits that were highlighted within the study and communicated to them prior to their consent. The IRB approval process also acted as a means of additional consideration towards ensuring an ethical and safe study for the participants.

The data that was collected was stored on a computer and several steps were planned to ensure safety and confirm that the data was secure. One laptop was utilized to collect data that had a biometric fingerprint for password security. Additionally, the data that was gathered was stored within password protected folders with a password that differed from the account password, ensuring that it had two-step authentication to be accessed. Finally, identifying markers from the participants were removed and pseudonyms assigned in replacement to ensure that the data was not able to be identified and traced back to an individual participant.

Summary

This research study dove into the factors that influenced students from low socioeconomic backgrounds desire to pursue a STEM career. The study addressed three research questions: What are the key barriers among students from low-income backgrounds that prevent from pursuing a career in STEM? How does student self-efficacy in students from low-income backgrounds affect their desire to pursue a career in STEM? How do students feel supported in motivating them towards STEM careers? As a result, a qualitative design was the most appropriate choice for the research study. More specifically, a transcendental phenomenological research design was the qualitative approach that was followed for the research interest. The following methods were followed as a result of the research design from guidelines from Creswell and Poth (2018), Moustakas (1994), and other researchers. Through observations, structured individual interviews, and focus groups, the lived experiences of the participants and their pursuit of STEM were described. The lived experiences of students captured through the data collection methods were analyzed for themes and safeguards such as member checks were used to ensured trustworthiness.

CHAPTER FOUR: FINDINGS

Overview

The purpose of this transcendental phenomenological study was to describe the lived experiences of students from low socioeconomic backgrounds that choose to pursue a career in STEM. By understanding student experiences specifically from low-income backgrounds through observations, interviews, and focus group interviews, schools can create systems and structures that support students from low-income backgrounds towards their desire to enter STEM careers. Understanding factors that students perceive positively and negatively influence student desire to pursue STEM can result in equitable practices and systems to support all students regardless of upbringing. The transcendental phenomenological qualitative research approach was chosen because of the importance of identifying structured themes and meanings to describe a phenomenon. The central research question was, "What are the experiences of students from low socioeconomic backgrounds pursuing a career in STEM?" The first sub-question was, "How does academic self-efficacy in students from low-income backgrounds affect their perceptions of the expected outcome and value of pursuing a career in STEM?" The second sub-question was, "How do students perceive classroom interventions to affect their expectancy and value of pursuing a career in STEM?" This chapter includes data from the observations, individual interviews, and focus group interviews.

Participants

There were 10 participants in the study and each of the participants was a student at STEM High School. Each participant met the criteria within the study. They all were from low socioeconomic backgrounds and qualified for the free and reduced lunch program. Additionally, each student had recently completed a one-year course in chemistry. They were between the ages of 13 and 17. Each participant was assigned a pseudonym to protect the identity of the participant. All participants agreed to audio recording for the data collection, and they and the parents of the participants were all provided with and signed the informed consent, affirming to the research procedures prior to collection. A participant table is included below:

Table 3

Participant Demographics

Participant	Gender	Grade	Age	Ethnicity
Merri	Female	11	16	Hispanic or Latino
Kobe	Male	11	16	Asian
Angel	Male	12	16	Hispanic or Latino
David	Male	11	15	Hispanic or Latino
Katie	Female	12	17	Hispanic or Latino
Dylan	Male	12	17	Hispanic or Latino
Alexa	Female	12	17	Black or African American
Alejandra	Female	11	16	Hispanic or Latino
Kobe	Male	12	17	Asian
Fatima	Female	12	17	Hispanic or Latino

Merri

Merri is a 16-year-old 11th grade student at STEM High School. She came from the traditional elementary and intermediate schools within the district boundaries. She intends to major in computer science in the future and is in the computer science pathway offered at STEM High School. Merri is an English language learner and is on a long-term English learner plan.

Kobe

Kobe is a 16-year-old 11th grade student at STEM High School. He did not follow the traditional district path from the local elementary and intermediate school. He came to America when he began high school. His first school in America was STEM High School and he intends to major in computer science in the future. Kobe is an English language learner. He does not have any family members that are working in STEM and lives with his mother and father.

Angel

Angel is a 16-year-old 12th grade student at STEM High School. Angel completed up to third grade in Mexico and then came to the traditional elementary and intermediate school pathway within the district boundaries before coming to STEM High School. He is an English language learner on a long-term English learner plan and is unsure of the specific STEM pathway that he'd like to pursue in the future but is interested in the cybersecurity industry.

David

David is a 15-year-old 11th grade student at STEM High School and went to the local elementary and intermediate school. He is currently interested in either engineering or fashion design and expressed that he typically had positive experiences growing up in STEM. David is an English language learner and is on a long-term English learner plan.

Katie

Katie is a 17-year-old 12th grade student at STEM High School. She moved to the district boundaries when she was transitioning from elementary to middle school and, as a result, was involved in STEM programs previously that are not offered at STEM High School. Katie was formerly classified as an English language learner; however, she was reclassified to non-English learner status. She is unsure of the specific career that she intends to pursue and expressed interest in pursuing a career in medicine or healthcare.

Dylan

Dylan is a 17-year-old 12th grade student at STEM High School and has a very high interest level for pursuing a STEM career. He is currently interested in pursuing a career in mechanical engineering or aerospace technology and would love to work with rockets in the future. Dylan was an English language learner but has been redesignated to English only. He followed the traditional elementary and intermediate school pathway within district boundaries, apart from his preschool to kindergarten education. He does not have family members that are currently in STEM.

Alexa

Alexa is a 17-year-old 12th grade student at STEM High School and has been within the district boundaries throughout her K-12 education, following the traditional elementary and intermediate school. Alexia is currently unsure if she wants to pursue a STEM career and is currently intending to pursue a career in cosmetology. She likes her STEM courses because she is able to see the overlap between her STEM courses and her future career desires, which is evident within her current science class, human anatomy and physiology. Alexa is not an English language learner and is characterized as English only.

Alejandra

Alejandra is a 16-year-old 11th grade student at STEM High School and came to the district boundaries and traditional elementary and intermediate school beginning in fourth grade. She was an English language learner and was redesigned as a non-English language learner in intermediate school. She is in the health and medical technology career pathway offered at her high school. She is interested in pursuing a career in STEM, specifically in healthcare, and expressed interest to be a future physician. She does not have family that are currently in STEM careers.

Juan

Juan is a 17-year-old 12th grade student at STEM High School. Juan lives with his mother and comes from a large family. None of his family members are working in a STEM career. His family members continually encourage him to enter STEM and he intends to do so with the motivation that he would like to give back to his family one day and support them. He is redesignated from English language learner classification. He is currently in the computer science and health and medical technology pathways due to his early completion of his AG requirements and is taking mainly electives for his senior year.

Fatima

Fatima is a 17-year-old 12th grade student at STEM High School. She has attended the traditional elementary and intermediate school pathway within the district throughout her K-12 education. She is currently in the computer science pathway and is also in a STEM fellowship that provides her free tutoring and field trips with a focus in STEM. In addition, she is a part of a cohort within the school called the CS Three Square cohort, which has allowed the cohort to move together from class to class within the computer science pathway since their ninth-grade year. She would like to work in computer science or engineering in the future. She is inspired by her sister, who graduated from college with a bachelor’s degree in computer science and is currently an intern at the NASA Jet Propulsion Laboratory.

Results

This study focused on a central research question and two sub-questions that sought to describe the barriers and motivations of students from low-income backgrounds pursuing a career in STEM. The participants were observed, engaged in a focus group interview, and individual interviews were collected in the research process. The themes were established from raw data within Vivo participant quotes and were organized into two categories: motivators and barriers, with included sub-themes. The themes, sub-themes, and associated research questions are described in the table below.

Table 4

Themes Organization

Themes	Sub Themes	Research Question
Early Exposure		CRQ
Hands On Learning	Labs	SQ2
Informal Learning	Field Trips	SQ1
	After School Programs	
	Digital Media	
Real-World Learning		SQ1
Greater Purpose		CRQ
External Support		CRQ
Accessibility of Teacher		SQ2
Lecture-Heavy Environment		SQ2

Early Exposure

One of the most common attributes of the experiences among the participants was an early exposure to STEM, whether in formal or informal learning experiences. Dejarnett (2012) found in a study assessing exposure to STEM among professionals that only 34% of participants were exposed to STEM prior to the age of 13. Within this study and in the context of STEM, early exposure was defined as exposure to STEM prior to entering ninth grade whether through formal or informal experiences (Dejarnett, 2012). Deslauriers et al. (2019) and Oje et al. (2021) both suggested that students who were exposed to STEM at an earlier age were more likely to perform stronger academically than students that first experienced hands-on STEM learning in high school.

Within the study, seven of the ten participants shared that they were exposed to STEM prior to ninth grade and these participants shared detailed instances where they remembered being engaged in STEM. These participants included Merri, Kobe, Angel, David, Katie, Alejandra, and Fatima. Merri shared, “It was definitely in middle school. Even though I don’t remember much of middle school science class, I remember how fun it was in computer science… It’s fun being able to be creative and make things with a computer.” In addition, Kobe, Angel, Alejandra, and Fatima also expressed that their earliest exposure to STEM was in middle school. Katie shared, “My first experience being and learning in STEM would be in third grade. It was being taught during class while discussing what the acronym means and understanding different topics such as the design process of engineering.”

Along with early exposure to what STEM is, all seven of the ten participants recalled their early experiences to STEM as hands-on and interactive experiences. Oje et al. (2021) discussed the role of active learning through hands-on experiences in STEM as key experiences that build positive academic self-efficacy among students. Additionally, these activities resulted in higher academic performance (Deslauriers et al., 2019; Oje et al., 2021). Merri described her early experiences with computer science and coding. Kobe highlighted, “I learned a lot of things that helped me apply it [science],” when describing how he utilized his math and science content in his hands-on activities. Similar to the experiences of Katie, Angel also described his early experiences in STEM by stating, “Building stuff like a bridge with popsicles, engaging in engineering activities and the design process as well.” Fatima, who recalled experiencing STEM in third grade, stated, “Understanding different topics such as the design process of engineering… sharing examples of STEM majors being offered in college, what stood out to me was computer science, life sciences, such as biology and astrobiology.” A shared commonality among the participants that had early exposure to STEM was that their experiences in STEM were centered around active learning and hands-on experiences.

In summary, each of the participants—Merri, Kobe, Angel, David, Katie, Alejandra, and Fatima—that had early experiences in STEM also shared a common characteristic, which was high academic self-efficacy. Each of these participants expressed that they would get high grades and five of the seven participants with early exposure described themselves as hard workers. Fatima, Alejandra, Katie, and Kobe all shared that they have passed all of their science classes with A’s. Angel also shared that in his 10^{th} grade science class, he “performed topnotch and my final grade of that was 100%”.

Hands-On Learning

Additionally, the theme of hands-on learning was evident when participants were asked what interventions their teacher could implement to motivate them towards STEM careers. When asked what would make a STEM career more appealing for them, Merri answered generally by saying, “I feel if you’re taking a science class, you should include more hands-on activities to engage the students," and Alejandra agreed by mentioning that there are many students likely to be interested in an engineering or hands-on STEM job, but that we haven't unlocked their desires yet because they may be unaware unless it is implemented within the classroom. Kobe mentioned in his suggestions to teachers to make STEM more appealing:

> Being allowed hands-on activities rather than just taking notes would be more of an enjoyable experience, and I guess, a memorable one for everyone. With it being enjoyable, I feel that would influence many students to pursue a career in STEM and so forth because of that enjoyable, memorable, hands-on activity that they experienced.

Alejandra continued elaborating on her experiences and suggestions for a teacher by mentioning her STEM course preferences and how they varied between her math and science classes. She said:

> When I think of STEM, I think, Oh my gosh, it's boring. It's just math and engineering. There's really nothing hands-on… I feel like it's more technical. In science, it's different. I feel if you just educate more and make it more project-based, I feel like people would want to pursue a career in STEM.

During Alejandra's observation, she did not express interest in the content and was on her phone for the majority of her period during a non-interactive worksheet time. Within both the question of what motivated participants to desire pursuing STEM and what would most likely make participants continue to pursue STEM, the answer of increased hands-on activities was shared by all ten participants, which highlighted how consistent these experiences were.

Labs

All participants expressed that hands-on learning was a motivator for their desire to pursue STEM in their STEM classes. Labs were critical experiences for each of the participants, and each participant described labs as "exciting" and "meaningful" when describing the impact labs had on their motivation to pursue STEM. For all ten participants, labs were foundational indicators of what made learning enjoyable for them. Merri stated, “I thought we’d move around a lot more in chemistry, but it was a lot of book work and math problems. I always imagined chemistry like the TV shows where they would mix chemicals and things would blow up.” For Merri, hands-on learning through labs was not only desired within the classroom, but the labs were foundational pieces of what she perceived science to look like. Kobe mentioned, “The hands-on activities… I like doing labs and moving around,” when describing what he enjoyed most about his science classes. Angel stated that in his 10^{th} grade experience, “She [teacher] made class really fun because of all the labs she did,” while David said a similar statement by stating, “We got to do a lot of labs and that was really fun.” In both Angel and David’s observations, movement was incorporated within their math classes, which led to positive reactions. Both appeared to be engaged throughout the entire period and David raised his hand three times during class.

Echoing the sentiments of all the participants, Forcino (2013) found that among students in lab-integrated classes and lecture-based only classes, students that were able to engage in the hands-on work displayed more active participation in the learning process and a deeper fundamental knowledge of science. They engaged in more inquiry, experimentation, and discovery, which were fundamental towards building skills in STEM careers. Additionally, Duban (2019) elaborated by finding that labs filled the gaps between science theory and application, which helped students understand science through meaningful experiences. Within this study, David also had experiences like the findings of Forcino (2013) and Duban (2019). When describing one of his science classes, he said:

> We got to do a lot of labs and that was really fun. Like being able to do labs where we could put some chemicals into a beaker and then make it foam up because of another chemical. I did really well on those.

This allowed him to demonstrate knowledge through hands-on experience. In comparison, he also said, “But then I didn’t do that well on tests. It’s usually how it is for me,” while further explaining that he does better academically when he is able to use his hands and explore. These findings were also shared by Katie, Fatima, and Alexa.

Informal Learning Experiences

Another sub-theme that was prevalent among the experiences of low-income students pursuing a career in STEM was the presence of informal learning experiences as central to their motivations. Of the ten participants, eight participants shared the positive impact of informal learning experiences, which appeared in the form of field trips, out of school STEM programs, and digital media.

Field Trips

Three participants—Merri, Kobe, and Fatima—all shared that key motivators towards STEM for each of them were field trips. Kobe said, “Field trips are also good and hands-on activities too… It made it more appealing to me and encouraged me to pursue computer science,” which highlighted that he viewed it as both a time for him to become exposed to the career and also learn through hands-on engagement in the process. Fatima was involved in an outside-of-school program that offered field trips, allowing her to learn more about STEM and narrow down which career path she wanted to go into. She said, “There’s so much going on and there’s so many different career paths,” and described that the field trips through her program allowed her to commit to engaging in a STEM path. In addition, Fatima differentiated between her academic and career paths. She mentioned that she “works pretty hard in school, so academically, I'm confident," but contrasted with, "When it comes to my interests, I sometimes feel lost… [out of school program name] is a good addition to my academic journey." Field trips supplemented Fatima's academic journey by focusing her career journey, while validating Kobe to continue pursuing computer science. Merri mentioned to a classmate during an observation that she wished that she was able to go to field trips more in class and the other classmate echoed her question. Verma, Dickerson, and McKinney (2011) reiterated the findings of this study, revealing that underrepresented students' interest and performance in their STEM classes were directly proportional to the level of integration that the curriculum had with field trips and community engagement.

After-School Programs

In addition to informal learning experiences through field trips, participants also mentioned out of school programs as critical programs that motivated them towards careers in STEM. Angel, Alejandra, and Fatima all highlighted in their focus group interview how important their programs outside of school were towards helping them narrow their career interest in STEM or engaging them further in "learning to love STEM". Angel was involved in a program that allowed him to participate in an academic decathlon, focused on the science section of the American College Testing (ACT) exam. He contrasted his joy for participating in the ACT competition and the test-like nature of it to actual in-class testing. He said:

> … everyone got together to answer science questions on a whiteboard. We wrote down the answer and then we would run to the front of the room to answer questions. The first person to write down the answer would win. I liked how we were in teams and trying to beat the other teams because it made learning science fun. I don't think it's fun when [science teacher] assigns a test, but in the competition, it was more hands-on, and I liked that.

Alejandra was involved in an afterschool medical pathways program, where she worked towards a medical assistant certification. She said, "I got to take a health class and a body systems class. In those classes, we basically got to learn how to take blood pressure, heart rate, and all of the stuff. If I keep on doing these classes, I can even be a medical assistant while I finish high school." When asked how she viewed STEM, she said, "I think that STEM is building robots," and mentioned later, "I don't want to enter STEM, but I want to pursue medical pathways," referring to her experiences in her afterschool biomedical/medical assistant pathway. Alejandra viewed STEM differently than the path that she was interested in; however, her afterschool pathways cultivated her desire to enter a STEM career unknowingly. Alejandra reiterated this viewpoint twice during her focus group, in addition to mentioning the impact of her medical assistant program in both occurrences. Fatima was involved in an informal learning program that was offered by the school through a private foundation. She mentioned, "They teach us more about STEM, what programs are offered, give us free tutoring, and take us on field trips. I learned a lot about STEM from the program and it made what I learned so much more fun." For Angel, Alejandra, and Fatima, each shared how their informal learning experiences were key motivators towards their desire to enter STEM.

Digital Media

Finally, another informal learning experience shared among seven of the ten participants that motivated them to pursue a career in STEM was digital media. Merri, Angel, David, Katie, Dylan, Alejandra, and Fatima all expressed motivation towards STEM as a direct result of digital media in the form of either TV shows like *Gray's Anatomy* or video games. In an earlier theme, Merri mentioned she believed that chemistry class would be more experimentation and "mixing chemicals and things would blow up", but her experience was more book work and problems. Merri had informal learning experiences with her perception of STEM through TV shows and stated, "I always imagined chemistry like the TV shows." Similarly, Katie asked during the interview, "Have you ever seen the TV show *Gray's Anatomy*?" She went on to explain:

> I love that show so much. Every time I watch the show, I get motivated because I see how interesting the jobs of the surgeons are and I would want to do something like that in the future. I'm also not afraid of blood.

She directly expressed that it was TV shows like *Gray's Anatomy,* a medical drama, that motivated her desire to enter STEM, specifically as a surgeon. She even distinguished how important the show was towards her motivation when she was asked what factors influenced her desire to pursue STEM by stating, "It's not necessarily a factor outside of school, besides Gray's Anatomy…," highlighting how she saw the show as the primary external motivator beyond school. During her observation within an Anatomy and Physiology course, she positively reacted to learning about the body and turned to a friend, saying that they heard that term in Grey's Anatomy.

For David and Fatima, their external learning experiences that motivated them towards a STEM career were in video games. The first career that Fatima seriously considered within STEM was a video game designer. She stated:

> At first, I wanted to be a game designer, but then I noticed the reality of it and decided to back out. I also found out I didn't want to code out games constantly on a specific due date, which already gives the pressure among the programmers.

Video game design sparked her interest in STEM, however through her out of school programs that included mentorship, she was able to receive support towards pursuing a computer science career. She elaborated on her reasons for shifting within STEM career interests by saying:

> I realized that for a game designer, the pay is lower than other STEM jobs. I love video games, but after learning about the pressure, I realized I wanted to do something different with my life. It's not that I don't want to work hard, but I want to make sure that I'm rewarded for the work that I do… Being exposed to different careers in my computer science cohort and mentors talking to me about different career paths helped me come to this realization.

While her interests in STEM shifted, her informal learning experiences introduced her into STEM careers. For David, he stated that he "loved video games" and related his love for games and technology in general by saying, "Science personally is like more interesting out of them all, but also technology and engineering combined can get really fun and creative." The intersection of the informal learning experiences within school allowed him to find science interesting. Merri had similar experiences. She shared, "Now, the software class that I am taking with my teacher has us making video games. It's really interesting because I feel like I get to do something in those classes." Fatima and Katie also shared within the focus group interview about how video games helped engage them in their STEM courses by developing interest. Video games, TV shows, and digital media were key motivators in seven out of the ten participants.

Real-World Learning

Just as the experiences of students outside the walls of the classroom through informal learning were motivators for the participants, another sub-theme that arose from the research was the importance of integrating real-world learning inside the classroom. Six of the ten participants expressed that real-world content connection was a motivator towards their interest in pursuing a career in STEM. Ackay (2007) discussed the importance of having students plan and solve real world projects and problems because it encourages students to take ownership of the learning. It also builds a bridge between the content and career skills (Ackay, 2007; Huber, 2019). For underrepresented students and students from low-income backgrounds this is important, as building authentic learning experiences that extend beyond the classroom and into the real-world allows students to develop belonging and identity in STEM, motivating them to pursue these careers (Singer, Montgomery, & Schmoll, 2020). For Kobe, Angel, Dylan, Alexa, Juan, and Fatima, this was integral towards their motivation in pursuing a STEM career, and they each shared how important real-world content integration was towards building their interest in STEM.

Kobe shared his value and desire for real world learning and what teachers could do to continue motivating him into a STEM career by stating:

> … Opportunities for students to keep showing interest for the careers when you introduce us to new things that relate to the career. When you create the career, showing the opportunity to see how I can use this in real life. When you teach the material, leave space for their creativity to grow and for their interest in STEM to grow more too.

He also included the value of field trips, scholarships, and asking [students] if there is more that I could discover and learn to apply the content. Juan said, "Well, the teachers, I feel like they had made learning fun and because of how fun they made it and related it, I gave my full attention so because I gave my full attention, I would know more about STEM in general and thus being more interested in just STEM jobs." When asked further about how teachers played a role in his knowledge of STEM, he shared, "I learned more about what STEM is and STEM things from my teachers. My family mainly tells me that it's a good career." Teachers' real world content integration provided a deeper understanding of STEM careers for Juan.

In addition, Alexa shared about her current desires to pursue a career focused on cosmetology and emphasized her love for science by sharing, "… it does apply to science. We need to know about human anatomy. We need to know about the skin, how chemicals, or these face masks, these products for the skin would react to certain other things that we put on skin." She described her favorite teacher by stating:

> They were actually my favorite teacher because they didn't tell me that I should be a doctor instead. They helped me find out how what we learned related to what I wanted to do, and it made me like her class.

Dylan shared:

> Teachers teach you about STEM. They teach you about the various careers that you could take. The various ways that you could get your diplomas and your degrees, and you could find the perfect career… I want to do something with chemicals. I want to do something in space. I want to do something engineering. The teacher has a big role because they teach you about it.

Dylan and Fatima both highlighted that the role of a teacher is not necessarily teaching you about the content, but how the content related to what they wanted to do, or in other words, the real-world experiences. The six participants highlighted the importance the bridge between the content and real-world experiences had on their motivations to pursue a STEM career.

Greater Purpose

Another theme that was common among the participants from low-income backgrounds pursuing a career in STEM was the importance of having a greater purpose in their career pursuits. Seven of the ten participants shared within the individual or focus group interview that they hoped to utilize their career in STEM to contribute to society, their families, or inspire others. Merri, Kobe, Dylan, and Juan expressed that they were pursuing a career in STEM because of financial motivation that would allow them to support their families. Angel and Katie shared that they would like to help others in a general sense. Finally, Fatima hoped to enter a career in STEM because she wanted to inspire females to see that they could also pursue a STEM career.

Merri mentioned that she hoped to enter STEM because of a financial motivator to create a better future for herself. Kobe elaborated, "To be honest, money… With money, just support my basic needs, like food, drink, butter… Coming from another country, I knew it was important and inspired me to look for a career to support my family too." Dylan also mentioned a financial motivator and said, "… the fact that STEM careers are able to help me sustain a good living, that influences [my desire to pursue STEM]." He continued to elaborate on how it went beyond a financial motivator too and into his ability to contribute to the development of rockets. He said, "Who doesn't want to be a $100,000 a year making scientist or aerospace engineer? That's very cool. Who doesn't want to help build a rocket?" Other participants, like Juan, resonated with Kobe by saying:

> Some of my family members actually work in STEM careers… They tell me how good it is. And that it's a good career to go into because it'll help me make money and be stable in the future. I want to be able to go into STEM like my family members so that I can help my mom.

For these participants, they all connected with the financial motivator of pursuing a career in STEM and utilizing the financial aspect to support their families or others.

Angel, Katie, and Fatima connected on the greater purpose of making a difference or inspiring others. Angel chose computer science because it is an engineering pathway; he was afraid of "possibly putting lives in danger", but he also mentioned:

> I just wanted computer science because we're in a world of technology, an age of technology so I want to be able to help whenever I can in case there's a technical difficulty and that's really why I want to pursue a cybersecurity job.

For Katie, her motivation to help others through her career in STEM came from personal experiences. She mentioned:

> … The reason I do want to pursue something in STEM is because my grandpa has heart problems and although I know I won't be able to help him, I do want to be able to help others. That is why I want to pursue being a cardiothoracic surgeon because although I won't be able to help him, I just feel like helping others would make me feel good and it's something that I really do want to pursue and do.

Her personal journey led to her motivation to pursue STEM, which resonated with Fatima. Fatima mentioned how difficult it was to pursue STEM when historically, students from low-income backgrounds and females in STEM were rare. However, as women in STEM became a more prevalent topic, her motivation sparked. She said, "I'd say my interest level in pursuing a career in STEM is very high considering the fact that I am very interested in specifically computer science, cybersecurity, and astrobiology. Women in STEM has become a bigger topic nowadays, and I'm glad that I get to be one of them or at least planning to in the future. Not only this, I also want to inspire females that they're capable in pursuing a STEM-related career, despite their skin, color, race, and income." Angel, Katie, and Fatima all connected in their experiences and desires to pursue STEM to help and inspire others. Additionally, Fatima was engaged throughout her entire observation and participated four times. She asked questions that went beyond the depth of the content that was currently being discussed.

External Support

The final sub-theme that was found within the experiences of students from low-income backgrounds pursuing a STEM career was the importance of external support, whether through teacher or family encouragement. Eight of the ten participants shared that they were motivated to pursue a STEM career as a result of teacher encouragement and three of the ten participants shared that they received family encouragement to pursue STEM. Bueno et al. (2022) found that students from low socioeconomic backgrounds displayed higher self-efficacy because of family encouragement to pursue a career in STEM, which also resulted in a statistically significant increase in percentage of students pursuing a STEM career. Additionally, they found it was even more important that students who were from both underrepresented backgrounds and a low-income family received family support in their pursuit of a career in STEM to decrease the risk of STEM attrition (Bueno et al., 2022). In previous studies that ranked influence levels of varying factors in students' desire to pursue STEM, parents and family was ranked second, while teacher and counselor influence followed as the third major influence (Hossain & Robinson, 2012; Taylor et al., 2004).

Angel, Juan, and Fatima all resonated in their experiences of receiving family support in their desire to pursue a STEM career. Angel mentioned, "Well, my whole family is basically engineers… Having a lot of cousins in STEM and my parents watching them have that comfort, I think I gained [the desire to pursue STEM] from them." Juan stated, "Some factors that influence my desire to pursue STEM is my family. Some of my family members actually work in STEM careers. Sometimes, when they talk about it, they say how good it is…" For Fatima, she shared her experiences of being recently motivated by her sister to pursue a STEM career. She elaborated:

> My sister graduated from college with a bachelor's degree in computer science, last year, and is considered as a first-generation graduate. She is a paid intern at a technology company as a software engineer, and now working computer science to gather some years of experience to seek something that interests her more. I found that inspiring.

Each of these participants had direct motivation from family.

In addition to the three participants being influenced by family members, they were also influenced by their teachers to pursue a STEM career. Additionally, four other participants agreed with them and were motivated also by teachers. Merri, Kobe, Katie, Alexa, and Alejandra were all also positively influenced to pursue STEM from their teachers. Merri, Kobe, and Katie mentioned that while their teachers were not high motivations in their influence to pursue STEM, their "support and answering questions" was very important to keeping their motivation to pursue STEM. Merri also added that she was inspired by teachers who were "very support or super understanding when things were difficult" and "being available when I needed it or just being flexible". Alexa, Kobe, Katie, Angel, and Juan all shared similar sentiments that a classroom practice which positively motivated them towards STEM was when teachers were "available to answer questions" and "support us from the sidelines". Kobe shared the importance of teachers in his journey to pursue STEM. He said:

> I also like it when I know that my teachers are really passionate about their teaching and their subject. Yeah, that just inspired me a lot to go into STEM and I was really positive about the class and subject when I had teachers like that.

Alejandra added that it is important for teachers to have interactive learning experiences by saying, "… educate more and make it more project based. I feel like people would want to pursue a career in STEM." For eight of the ten participants, they shared the importance of positive teacher influence on their desires to pursue STEM.

Accessibility of Teacher

During the observations and interviews, a common sub-theme across eight of the ten participants was a negative influence towards their desires to pursue a STEM career when teachers were not able to address the questions of students or assist students in completing coursework. Chin and Osborne (2006) discussed the importance of student questioning towards scientific inquiry and curiosity. They explained that encouraging student questioning built scientific reasoning and meaningful learning. More notably, students that asked questions were found to be proud of their question, regardless of the depth of the answer. When asked to explain how they felt, they mentioned that when they asked questions, they found the content interesting (Chin & Osborne, 2006). For the participants in the study, six of the eight described in the interviews that they were discouraged to enter STEM careers when teachers did not answer their questions.

Merri, Angel, Katie, Alexa, Alejandra, and Juan all expressed that in their own individual experiences, they've encountered moments where teachers would not answer their questions or be present to directly assist them, and their motivations to pursue STEM were negatively affected. Merri mentioned:

> A negative learning experience was when a teacher I had wasn't the most available. When I needed help, I would ask them and they'd just tell me to ask someone around me,

> rather than explaining the actual material and concept to me." She mentioned later that it "pushed [her] away from STEM."

When Angel was asked what negatively influenced his confidence in STEM, he said:

> When teachers don't want to help their student, like let's say you're stuck and you're trying to build something and you don't know how to put it together, and your teacher just watches you and doesn't tell you what to do. Teachers are supposed to be a support stand in your life, and you can ask them whatever you want, and they'll gradually help you, and you can learn more just from that. If your teacher doesn't want to help you at all and you're just there to suffer, you don't know what to do to succeed then that's what can bring down my morale and make me lose confidence and self-esteem goes down too.

Katie and Alexa answered for that question when a teacher "yells at you for not understanding" within their focus group interview. Katie elaborated, "It's not our fault that we don't understand it all the way. Or like how they wanted. One time, all of our test scores were low, so she got mad at us."

During Dylan's observation, he actively had his hand raised during an activity, however the teacher continued forward and acknowledged Dylan by stating, "I'll get to your question in a bit." Later in the observation, the teacher reacknowledged his question; however, Dylan appeared disappointed that he forgot his question. During his individual interview, he reiterated that a motivator for his desire to pursue a STEM career was the teacher's ability to answer questions and connect the content to STEM. This experience was shared in David's individual observation, where he had his hand raised, but his teacher did not notice his hand. His peer later asked, "Do you want to ask?" David responded, "No, it's ok." He did not further pursue his question. He appeared disappointed as well and continued doing his work. During the first half of the period, he was participating by raising his hand twice for two questions to answer. However, during the second half of the observation, after the teacher did not notice his question, he did not raise his hand for one subsequent question from the teacher about the content.

Lecture-focused

In addition to the accessibility of the teacher being a common negative barrier for many of the participants, all ten of the participants expressed that a lecture-focused and non-interactive environment was a significant aspect of the classroom that negatively influenced their desire to pursue a career in STEM. The participants mentioned COVID-19 as the reason for many of their lecture-focused or non-interactive learning environments. Katie stated, "I mentioned it was all online and there wasn't any group work. It's not [teacher name]'s fault because I don't even know what she could have done, but it sucked. It was lonely." Kobe agreed. He stated:

> I would say my worst experience in a STEM class was in 9th grade. Well, it's not the worst one because of anyone, but because of COVID and it was online. So, in my Living Earth class, it was really hard to focus and to be able to learn and you know, understand every single part of the material. So it was not good. Like I know the teacher tried, the student tried, my classmates all tried, but it didn't really work out. This is online and not everyone is made for online study. It wasn't engaging or motivating at all, so yeah, that was probably my worst experience with a STEM class.

Katie, who was not in the same class as Kobe, also elaborated by saying, "My Living Earth class was also the most boring science class I took. It was online. So, there was no group work and no hands-on activities. I think what makes a really good class is when there's both of those things combined." Alexa, Alejandra, Fatima, and Juan all shared similar experiences and mentioned "no group work", "no interactive activities", and "no labs". In addition, when a science class was primarily instruction without interaction, Merri, Kobe, David, Dylan, and Alexa all mentioned no hands-on activities and mentioned "no labs" as a key reason for feeling "unmotivated" in their STEM classes and in pursuing STEM.

Outlier Data and Findings

Within the research study, one outlier finding was identified. The important sub-theme that was an outlier finding was the unexpected theme of COVID-19. The unexpected theme is described below.

Outlier Finding #1: COVID-19

Throughout the research process in the individual interviews, focus groups, and observations, the word COVID-19 and the experiences of COVID-19 were shared among seven of the ten participants. COVID-19 impacted all seven of the participants who shared by negatively influencing their passion and motivation for pursuing a STEM career. David mentioned, "No offense to the teacher, but when all of the lessons [during COVID-19] are just sit down and write, without being able to do anything, no one wants to listen. My biology class, we just sat there most of the time. I guess sometimes we had an online lab, but even that wasn't the same because it was just clicking buttons and moving things around." Dylan described online school as a result of COVID-19 as "really frustrating" and he was glad that school type was over. Kobe mentioned that it was the worst experience in a STEM class. He stated, "I would say that my worst experience in a STEM class is in 9th grade... because of COVID and it was online." The unexpected theme of the impact of COVID-19 on the participants' motivation towards pursuing a career in STEM was shared among all seven participants verbally. During an observation, Alejandra and Alexa both brought up COVID-19 independently in class, jokingly when talking with a classmate about not understanding the content. They mentioned, "Oh, it's because it was on Zoom [that I don't understand]," and, "Better than COVID," when describing the interest level of an activity.

Research Question Responses

The study was guided by a central research question and two sub-questions. This section provides succinct answers to the research question using in vivo citations. The central research question centered around the experiences of low-income students pursuing a STEM career is addressed first, followed by the two research questions around their academic self-efficacy and expectancy and value of pursuing STEM.

Central Research Question

What are the experiences of low-income students pursuing a career in STEM? The participants experienced early exposure to STEM careers, received external support either from their family or teachers, and were found to have a greater purpose for pursuing a career in STEM. Katie shared, "My first experience being and learning in STEM would be in third grade. It was being taught during class while discussing what the acronym means and understanding different topics such as the design process of engineering." In addition to having hands on learning early, Merri shared, "Even though I don't remember much of middle school science class, I remember how fun it was in computer science… Its fun being able to be creative and make things with a computer." Participants also received external support from either their families or teacher. Juan shared, "Some factors that influence my desire to pursue STEM is my family. Some of my family members actually work in STEM careers. Sometimes, when they talk about it, they say how good it is." Fatima also related by sharing her experiences having a sister in STEM. She said, "She is a paid intern at [a technology company] as a software engineer… I found that inspiring." For those that did not have family in STEM, they shared that their experiences pursuing STEM were motivated also by external support, but by teachers. Kobe said, “I also like it when I know that my teachers are really passionate about their teaching and their subject. Yeah, that just inspired me a lot to go into STEM and I was really positive about the class and subject when I had teachers like that.” Five of the participants noted that they were positively influenced into pursuing STEM careers when teachers “supported from the sidelines”. Merri, Kobe, and Katie stated that their teachers motivated and influenced them to continue pursuing STEM when they were “available and answered questions”.

Sub-Question One

How does academic self-efficacy in students from low-income backgrounds affect their perceptions of the expected outcome and value of pursuing a career in STEM? The factors that influenced participants’ academic self-efficacy directly were a combination of informal learning experiences and real-world integration of content to their careers. Informal learning experiences were shared among the participants and positively influenced their academic self-efficacy and motivation to pursue STEM. Motivation within STEM was found to be influenced by formal and informal learning environments. Kitchen et al. (2018) found that informal learning environments outside of the classroom displays a positive influence on student motivation, while formal learning environments influences students to have lower motivation and self-efficacy. Roberts et al. (2018) added that students who were exposed to hands-on learning environments and informal learning experiences have a higher self-efficacy and academic success in STEM. Merri, Kobe, and Fatima all shared that “field trips” were key parts of their learning experiences. Kobe elaborated, “Field trips are also good and hands-on activities too… It made it more appealing to me and encouraged me to pursue computer science.” For Kobe, Merri, and Fatima, their experiences through field trips encouraged their academic self-efficacy.

In addition to field trips, Roberts et al. (2018) and Kitchen et al. (2018) discussed that informal learning experiences positively influence student's academic self-efficacy and overall motivation to pursue a STEM career. Fatima connected her academic strengths with the importance of her learning experiences when she said, "[I] work pretty hard in school, so academically, I'm confident, but when it comes to my interests, I sometimes feel lost… [out of school program name] is a good addition to my academic journey." Angel and Alejandra resonated and stated that their experiences helped them "learn to love STEM". Alejandra built her confidence through her medical assistant program. She mentioned, "We basically got to learn how to take blood pressure, heart rate… If I keep doing these classes, I can even become a medical assistant when I finish high school." Merri built her academic self-efficacy and her interest in STEM by learning through TV shows. She stated, "I always imagined chemistry like the TV shows." Katie connected with her when she described the show *Gray's Anatomy* and stated, "I love that show so much. Every time I watch the show, I get motivated because I see how interesting the jobs of the surgeon are and I would want to do something like that in the future." She mentioned later, "[*Grey's Anatomy*] makes me learn more in class because it makes learning fun."

Additionally, real-world content integration developed students' academic self-efficacy. When learning was connected to the real-world, specifically a career, Dylan said, "[STEM] classes are interesting to me, just because the topics are very, very high paying and very, very cool. Who doesn't want to be a $100,000 a year making scientist or aerospace engineer?" In contrast, when the content wasn't connected to the real world, Alejandra stated, "We learn a lot of things that they keep on telling us is important, but what's the point if I'm not going to use it or if I don't know what to use it for?" Alexa loved science and built her academic self-efficacy, describing her love for it by saying, "… it does apply to science. We need to know about human anatomy. We need to know how the skin, how chemicals, or these face masks, these products for the skin would react to certain other things that we put on the skin." Alexa later elaborated on her favorite teacher and said, "They helped me find out how what we learned related to what I wanted to do and it made me like her class." Dylan connected to Alexa and described the importance of discussing career. He said, "Teachers teach you about STEM. They teach you about the various careers you could take." All the participants that expressed the importance of connecting content to the real world also expressed similar thoughts like, "I do well in my science classes", "I have never gotten below an A in my science classes", and "I am strong academically," which are indicators of high academic self-efficacy.

Sub-Question Two

How do students perceive classroom interventions to affect their expectancy and value of pursuing a career in STEM? Participants' perceptions of classroom interventions heavily affect their expectancy and value of pursuing a STEM career. These participants were influenced by teachers engaging in answering participants' questions, being available to help and be flexible, and implementing classroom interventions that focused on collaboration and communication. Merri stated that she was inspired by teachers who designed their classrooms to be supportive and student-centered. She stated, "I am inspired by teachers who are very supportive or super understanding when things were difficult… being available when I needed it or just being flexible." Alexa, Kobe, Katie, Angel, and Juan shared these thoughts and stated that they were positively motivated towards STEM when teachers built a classroom where they were "available to answer questions" and able to "support us from the sidelines". Additionally, teacher passion played a key role in motivating students towards pursuing a STEM career. Kobe stated, "I also like it when I know that my teachers are really passionate about their teaching and their subject." Alejandra stated that people would be more interested in STEM when it was more project-based. Teacher interventions played a critical role in these students pursuing a career in STEM and working towards positively motivating them towards STEM.

In contrast, when teacher interventions were not focused on collaboration, communication, and hands-on learning, participants' motivation towards pursuing a STEM career was negatively influenced. When asked what negatively influenced Angel's desire to pursue a career in STEM, he stated:

> When teachers don't want to help their student, like let's say you're stuck and you're trying to build something and you don't know how to put it together, and your teacher just watches you and doesn't tell you what to do… If a teacher doesn't want to help you at all and you're just there to suffer, you don't know what to do to succeed and that's what can bring down my morale and make me lose confident and self-esteem goes down too.

Alexa and Katie agreed and added that when a teacher "yells at you for not understanding", it also results in a decreased expected outcome to pursue a STEM career and less value due to decreased confidence. Dylan was observed being disappointed during his observation when a teacher was not able to answer his question and he forgot his question, telling his peer, "Never mind, I forgot," afterwards. He also mentioned that it decreased his desire to pursue STEM when teachers did not acknowledge his questions.

Summary

This chapter focused on the results of the study and included in vivo quotations of the experiences of the participants. The experiences of the participants and the data collected was organized into eight major themes, which were early exposure, hands on learning, informal learning, real-world learning, greater purpose, external support, accessibility of teacher, and lecture-focused environment. The five sub themes identified were labs, connection to real world, field trips, after school programs, and digital media. A significant finding was the experiences that were motivators of students from low-income backgrounds were centered around learning experiences in the classroom that were real-world and interactive through field trips, labs, informal learning programs, and projects with design, build, and create elements. Outside of the classroom, a significant finding was that the participants were exposed to STEM early in their K-12 education and had a greater purpose for pursuing STEM, whether that was financial, supporting family, or making a difference in the world. Additionally, the experiences of participants that made them less likely or motivated to pursue STEM careers were centered around classrooms that were not interactive and primarily lecture-based environments. Participants also were influenced to not pursue STEM careers when they believed that their teachers were not there to help them or did not engage in their inquiry.

CHAPTER FIVE: CONCLUSION

Overview

The purpose of this transcendental phenomenological study was to study the lived experiences of students from low-income backgrounds and their motivations towards pursuing a STEM career. The data collection process included individual interviews, a focus group interview, and individual observations. The culmination of the data from each of these research methods helped to describe the lived experiences of the participants. After the analysis of the research results and development of findings, the discussion provided a succinct narrative of the themes that related to the experiences of students from low-income backgrounds as they pursued STEM, and the motivations and barriers that existed. This chapter includes the following subsections: (a)interpretation of findings, (b) implications for policy and practice, (c) theoretical and methodological implications, (d) limitations and delimitations, and (e) recommendations for future research. In addition, this chapter summarizes the major themes and subthemes, central research question, and the two sub questions.

Discussion

The purpose of this transcendental phenomenological aimed to describe the lived experiences of students from low-income backgrounds and their experiences, including motivations and barriers, pursuing a career in STEM. This study utilized a qualitative research method because of the focus on observational analysis through observation, description, and explanation of an observed phenomenon (Aspers & Corte, 2019; Gerrish & Lacey, 2010). A phenomenological study was the most appropriate choice for the study for the purposes of identifying shared experiences of individuals within the same phenomenon (Creswell & Poth, 2018). The literature, research framework, and analysis of data and findings were epitomized by the theoretical framework of Vroom's expectancy-value theory. Expectancy-value theory discusses how individuals perceived the outcome to occur (expectancy) and the worth of an outcome on an individual (value) as two predictors of whether an individual would place their foundation for their actions and behaviors towards achieving an outcome (Wigfield et al., 2009). Eight major themes were identified, which were early exposure, hands on learning, informal learning, real-world learning, greater purpose, external support, accessibility of teacher, and lecture focused environment. The five sub themes identified were labs, connection to real world, field trips, after school programs, and digital media.

Interpretation of Findings

This section is a summary of the major themes from Chapter Four and includes interpretations by the researcher. The purpose of the interpretations is to develop new findings about student experiences from low-income backgrounds pursuing a career in STEM and the motivators and barriers associated with their experiences. The interpretations work to synthesize and connect the phenomenon, participant experiences, literature, and theoretical framework.

Summary of Thematic Findings

During this study, eight major themes and five subthemes emerged from the analysis of the experiences of students from low-income backgrounds. The major themes that were identified were early exposure, hands on learning, informal learning, real-world learning, greater purpose, external support, accessibility of teacher, and lecture focused environment. The sub themes that were identified were labs, connection to the real world, field trips, after school programs, and digital media. The interpretations of these themes were developed by the researcher under the theoretical framework of Vroom's expectancy-value theory. Vroom's expectancy-value theory describes that the two key factors towards decision making stems from the perception of the expected outcome and the value of pursuing the outcome (as cited in Wigfield et al., 2009). The two thematic interpretations derived from the foundation of Vroom's expectancy-value theory are expectancy and value.

Expectancy Interpretation. Vroom (1964) postulated that one key aspect towards a student's motivation to pursue an outcome is on their perceived expected outcome. The anticipated outcome influences whether students perceive that it is worth pursuing. The expectancy interpretation of the lived experiences of the participants focuses on the motivators and barriers that influence how students from low-income backgrounds perceive their outcome of pursuing STEM. According to the findings within this study, students that were exposed to STEM at an early age were more likely to experience an increased positive expected outcome from their motivation to pursue STEM. Most participants that experienced STEM at an early age in their K-12 education were more likely to express positive outcome expectancy in their future STEM careers, as well as display increased engagement in their STEM courses. External motivators also played a key role in increased perceived expected outcome with student desire to pursue STEM careers. Though less than half of the participants had direct parental support towards pursuing a STEM career, most experienced external motivation from their teachers. Participants who had external motivation were more likely to express that they had high academic self-efficacy and positive career outcome expectations.

In addition to external support from teachers, a commonly expressed phenomenon was that participants who had more real-world learning experiences, whether through informal learning environments or in-class content connections to jobs, were more likely to know which careers within STEM they were interested in. This resulted in a positive impact on overall expected outcomes for most participants that had these experiences. In contrast, a classroom intervention that resulted in decreased expected outcome because of decreased perceived belonging in STEM was teacher accessibility. Most participants noted that when teachers did not engage with their questions that arose due to curiosity, they were less likely to believe they could succeed in STEM. Participants observed within the STEM classrooms who did not feel seen appeared visibly disappointed, in addition to expressing that they felt they did not have support towards their goals.

Value Interpretation. Secondly, Vroom (1964) explained that a second key indicator for predicting whether someone will pursue an outcome is the person's perceived value of the outcome. The value interpretation of the participants from low-income backgrounds pursuing a career in STEM focuses on the motivations and barriers influencing how they perceive the value of pursuing STEM. A phenomenon found within the study was that participants who had external support, whether family or teachers, that shared the benefits of STEM careers had a higher perceived value of pursuing this pathway. In addition, participants who experienced more real-world learning in their classrooms connecting to their communities also appeared to be more engaged in their STEM courses, as well as had a high self-efficacy and perceived value of STEM careers. Participants with these experiences shared that they were positively motivated towards STEM when teachers connected the content they were learning to the careers in which they were interested. Finally, a key motivator towards STEM, as a result of increased perceived value among participants, was a sense of a greater purpose if they did pursue STEM. Participants that both were interested in STEM and had a greater purpose in mind expressed hoping to use their career to make a difference in the world, in their families, or better their own lives from self-motivation. These participants had a high perceived value of STEM careers. In contrast, learning environments that were on the other end of the spectrum because they were lecture-heavy resulted in student disinterest. Within these learning environments, the participants who were in lecture-focused environments appeared unengaged, and later shared they did not see value in the content they were learning because it did not lead to a future career.

Implications for Policy or Practice

This phenomenological research study provides implications for policy and practice within K-12 STEM education. The policies and practices suggested within the study require the involvement of multiple stakeholders, between individual persons, organizations, and school systems. For school systems, this involves the inclusion of structures and supports for STEM education that brings the real-world into the classroom, while simultaneously allowing for students to extend beyond schools and into communities. It involves families, teachers, and communities to encourage students to enter STEM careers and build positive identity in STEM.

Implications for Policy

The findings within this research study and the analysis of data indicate that schools need to adopt standards focusing on real-world and hands-on learning. Currently, the school has adopted the Next Generation Science Standards (NGSS), which focus on phenomenon-based learning experiences that engage students in real-world instruction. However, students should continue to be engaged in learning experiences that extend beyond real-world examples and into learning experiences that are connected to the students' communities and identities. The school may choose to adopt civic engagement practices that allow students to develop projects, involving students in their own communities. This study found that students' identities within STEM are influenced by their amount of real-world instruction within the classroom. In addition, this study encourages leadership to focus on allowing all students to be engaged in a Career Technical Education (CTE) pathway that allows students to build real-world skills and practical knowledge in STEM careers. The school should implement systems that allow students to engage in after school learning initiatives focused on STEM education and building positive academic self-efficacy. These academic programs should be free for all students to provide an equitable option for students from all socioeconomic backgrounds.

In addition, schools should implement policies that require informal STEM learning experiences, beginning at the elementary school level. This research within this study found that for students from low-income backgrounds pursuing a career in STEM, early exposure was a critical component to building motivation in pursuing these careers. These informal STEM learning experiences should include hands-on activities that foster students' ability to design, create, and build. STEM Unified School District currently requires elementary school teachers to teach students using the NGSS framework for elementary students. However, schools should also implement policies that allow students to be exposed to not just the practical theory and content of STEM, but real-world STEM careers that they could enter based on the content that is taught. These STEM learning experiences should begin in the classroom and then should also be taken beyond the walls of the school into their communities at an early age.

Implications for Practice

This phenomenological research study indicated the need for students to have a STEM education that is both rich in real-world learning and positive self-efficacy in schools and outside of schools. With the implementation of policies that allow for students to experience STEM education beginning in primary school, students will be able to be exposed to STEM at an earlier age. These experiences should allow for hands-on learning activities, such as engineering or inquiry-based problems that require creativity and building, to foster curiosity in STEM. Additionally, these activities work to build memorable learning experiences at an earlier age and build students' academic self-efficacy. With the implementation of free after school learning programs, schools may provide students with more experiences to engage in STEM through hands-on and informal learning environments. Parents may be encouraged to allow their kids to participate, and these programs may be programs that also engage parental involvement to foster family influence. By incorporating more stakeholders encouraging students to participate in STEM, students from low-income backgrounds may have a greater number of opportunities to build academic self-efficacy and motivation.

Parents may further motivate students to enter STEM by building their self-efficacy and encouraging them to pursue these careers. Schools should implement STEM program nights that are informational to educate parents and the community in the various careers and pathways that their child may pursue. During these informational nights, schools should encourage parents to take advantage of informal learning experiences offered at no cost by the school. Additionally, parents, teachers, and administrators should work together to build rich community programs that allow students to see they belong in STEM and have multiple people supporting them towards these careers. Family and teacher motivation played a key role in motivations shared among participants within this study. Through these collaborative stakeholder meetings, notes should be documented that allow for the development of programs that meet the needs of the learners. For example, if the stakeholder meetings indicate that gaming is a large part of the culture of the school, gaming should be the focus in clubs and afterschool programs, while connecting this interest to computer science or other STEM careers.

Theoretical and Empirical Implications

This section explores the theoretical and empirical implications that arose from this research study. This study reexamines the theoretical context by which this study was designed within the context of the findings of the study. Additionally, empirical implications are discussed with consideration to previous research and the findings of the study. The unique findings that were a result of these two implications are discussed and any differences that were identified are also included. The theoretical and empirical implications are also discussed in the context of previous research and evaluated for the ways in which they are similar and different.

Theoretical Implications

Vroom's expectancy-value theory describes the influence of a person's perception of the outcome, or the expectancy, and the value of pursuing an outcome as two integral predictors towards behavior (Vroom, 1964). Students from low-income backgrounds were found to be less likely to pursue a career in STEM because of lower perception of positive outcome and value towards this path (Wu, 2019). Of the factors that influence STEM motivation among students from low-income backgrounds, socioeconomic status and parental education are the greatest (An et al., 2019). Within the context of Vroom's expectancy-value theory, it was important that the factors influencing expected outcome and value of pursuing STEM were identified. Lee and Burkam (2002) found that environmental and social upbringing are two predictors. Due to their environment, parent and role model influence, social influence, and access to opportunities, students from low-income backgrounds are less likely to pursue STEM careers (An et al., 2019; Lee & Burkam, 2002; Roberts et al., 2018).

From a theoretical context, understanding the expected outcome and perceived value of students pursuing STEM from low-income backgrounds would allow for greater interventions and supports for students, and this would increase outcomes. This would allow for a more diverse, equitable STEM industry and close opportunity gaps. The motivations identified within the study included being motivated to perceive a higher expected outcome in pursuing STEM by experiencing STEM early, engaging in hands-on learning through labs, having opportunities to engage in informal learning through field trips, after school programs, and digital media, and receive external support. Shared theoretical perspectives during this study were that students' perceptions of STEM were more positive when they had a chance to engage in informal learning experiences in the context of summer programs (Kitchen et al., 2018; Roberts et al., 2018). Additionally, students from low-income backgrounds who received support from parents were likely to have higher expected outcomes towards pursuing STEM and higher likelihood of entering these careers (Lee & Burkam, 2002; Wu, 2019). The research within this study coincides with the current theoretical perspectives on STEM education. In addition, the participants also highlighted that when they experienced a sense of greater purpose in pursuing STEM, they were more likely to have a higher perceived value of pursuing STEM and motivation towards pursuing these careers.

Empirical Implications

Current empirical implications of literature focused on student motivation towards STEM careers; however, research was lacking in studies that specifically assessed student motivation towards STEM from low-income backgrounds. Similar research used broad focus approaches that acknowledged the need for further research on STEM motivation from different student groups, locations, and backgrounds (Kent & Giles, 2017; Kitchen et al, 2018; Roberts et al., 2018). Furthermore, a broad research approach and differentiation of instruction found that within four grade levels, the overall learning processes of students differed drastically (Bondie, Dahnke, & Zusho, 2019). They concluded that instructional interventions to meet the needs of students need to be considered within the specific socioeconomic and cultural contexts of the schools.

In previous literature, summer STEM initiatives, parental involvement, and self-efficacy influenced student desire to pursue a career in STEM. Students who engaged in summer informal learning experiences that allowed them to explore STEM had more positive motivations and expected outcome of pursuing these careers (Roberts et al., 2018; Salto et al., 2014). Additionally, students from low-income backgrounds who had parental involvement in their education were more likely to pursue STEM careers as well because of the support (Lee & Burkam, 2002; Wu, 2019). Finally, students in one study who had higher academic self-efficacy had higher expected outcomes and value in pursuing STEM, particularly in pursuing medicine (Hayat et al., 2020). The participants in this present study did mention that informal learning experiences were critical towards their motivation, expected outcome, and value in pursuing STEM. The study expanded on previous research, finding informal learning experiences that increased motivation for low-income students included field trips, after school STEM programs, and digital media through TV shows. Additionally, participants had increased perceived value when they believed there was a greater purpose for them pursuing STEM, often including supporting a family member(s). In contrast, participants experienced decreased value and expected outcome when there was low teacher accessibility and teachers did not engage in inquiry-based learning. Other findings reiterated the value of informal learning experiences but added it was important that participants were able to experience these programs early in their education. allowing for development of expected outcome and value of STEM careers for students from low-income backgrounds. Schools and communities should dedicate resources towards increased development of formal and informal STEM learning experiences for students from low-income backgrounds. These programs should be free to allow for equity and accessibility, as well as implementation early in a child's education. Increasing development of STEM learning experiences through schools, the community, and parental engagement would allow for a real-world learning experience unique to the communities that the students are from.

This ultimately would be a step towards developing positive expected outcome and perceived value in STEM careers among students from low socioeconomic communities.

Limitations and Delimitations

In this section, the limitations and delimitations of the study are discussed. The limitations of this study included the effect of the pandemic lockdowns and the experiences that were a result of online education. This research study occurred one year after the school district returned from pandemic lockdowns due to COVID-19. During the lockdowns, schools shifted to distance learning, with academic instruction occurring through video conferencing software. Many of the participants' responses included reflections on the online education. Of the ten participants, nine shared their experiences with school in an online setting. They all connected with how the distance learning negatively impacted their educational experiences and how they were in all non-interactive learning environments. As a result, their experiences, motivations, and barriers in pursuing a career in STEM were influenced heavily by their recent experiences with the pandemic. In addition, even during observations of students physically in class, they still made references to online learning in a negative context. The participants' experiences were currently impacted by their recent traumas and negative learning experiences during the pandemic.

In addition to the pandemic affecting the experiences of students and their perceived barriers of pursuing a career in STEM, it also influenced their experiences in the STEM classes. When participants were explaining how teachers in their STEM courses positively or negatively influenced their motivations to pursue a career in STEM, they shared that their experiences in an online STEM class were different from what they would have experienced in that same class in-person. Additionally, the delimitations of this study were including participants under the age of

18 and older than 13. The intentional decision to include delimitations of participants interested in pursuing a career in STEM for participants specifically under the age of 18 was due to the nature of the study focused on the secondary education level. This study was conducted with the delimitation of a phenomenological study over other study methods. The intentional research design was because although the students are all from the same school and are choosing a career in STEM, their experiences differ, whether they grew up in STEM Unified School District, moved into the district boundaries recently, or even had different experiences at home. A phenomenological research design allows for analysis of the shared experiences of multiple participants sharing the same phenomenon. Finally, a delimitation within the study was that all the participants had to have completed a chemistry course. These delimitations ensured that all the participants from low-income backgrounds could give a full account of their experiences pursuing STEM and would have common characteristics.

Recommendations for Future Research

This transcendental phenomenological study was intended to examine the lived experiences of students from low-income backgrounds pursuing a career in STEM. During the study, participants shared that a teacher engaging with their questioning motivated them to be more curious and interested in STEM careers. In addition, when teachers did not engage with the participants' questions or address them, they were less likely to be motivated to pursue STEM careers. One area of further recommendation is to study the effects of the Next Generation Science Standards storyline model for curriculum development on student interest to pursue a career in STEM. The storyline model seeks to engage learners in the practice of inquiry by beginning a unit with an investigative phenomenon and developing subsequent instructional segments that lead to understanding the phenomena solely from student curiosity (Reiser et al., 2021). As the NGSS model continues to work towards being the majority model, understanding the impact of cultivating student inquiry and the impacts on motivating students towards a STEM career is integral towards assessing the effectiveness of a storyline (National Science Teaching Association, 2021). Additional research may lead to further understanding of the impacts of student-centered instruction on STEM motivation.

Another recommendation for future research is a long-term research study on students from low-income backgrounds pursuing a career in STEM who expressed high academic self-efficacy because of the themes and sub themes identified within this study. By understanding the impact of academic self-efficacy, high expected outcome, and high value on STEM retention, a greater understanding could be gained of how schools can build systems that encourage students to remain in their STEM track. Expanding the research study with a long-term analysis and wider scope can allow for a deeper understanding of the experiences of low-income students and uncover motivations and barriers that may not have been identified within the study.

In addition to this study that focused on student experiences from low-income backgrounds pursuing a career in STEM, understanding how these experiences differ from students from affluent backgrounds is a third area of future research. A comparative analysis between the experiences of students from low-income backgrounds and affluent backgrounds would allow for a greater understanding of how the motivations and barriers differ among the two groups. Many districts restrict the ability of a student to attend a particular school because of city lines (Vaughn & Witko, 2013). As a result of this, schools often experience a high distribution of students from either low-income or high-income backgrounds, but not balanced. Understanding whether the motivations and barriers of students from different backgrounds and their desires to pursue a STEM career differ would allow for a better understanding of how schools can support the students within their communities and provide programs that meet the individual needs of their learners. Expanding beyond the research of this study would allow for more equitable programs for students from all backgrounds, increasing motivation to pursue STEM and decreasing barriers.

Conclusion

This transcendental phenomenological study examined the lived experiences of students from low-income backgrounds pursuing a career in STEM while identifying the motivations and barriers that exist. The phenomenon that influenced the development of the study was the significantly lower percentage of students from low-income backgrounds pursuing a STEM career in comparison to their peers from affluent backgrounds (Diekman & Benson-Greenwald, 2018). The lack of students entering STEM careers from low-income backgrounds displayed an equity gap that was continuing to increase and needed to be addressed by understanding how students experienced their pursuit towards a career in STEM (Rozek et al., 2019). The study was approached from the foundational theoretical framework of Vroom's (1964) expectancy-value theory, postulating that there are two key factors which determine a person's decision to pursue an outcome: the perceived expected outcome and value. While previous literature identified the motivations and barriers of students pursuing STEM, there was a literature gap that existed specifically among students from low-income communities (Bondie, Dahnke, & Zusho, 2019; Kent & Giles, 2017; Kitchen et al., 2018; Roberts et al., 2018).

I examined the lived experiences of the ten participants using individual interviews, a focus group interview, and observations. Eight major themes and five sub themes were identified from the analysis of the participant experiences. These major themes were early exposure, hands on learning, informal learning, real-world learning, greater purpose, external support, accessibility of teacher, and lecture focused environment. The sub themes identified were labs, connection to real world, field trips, after school programs, and digital media. Analysis from the foundation of the theoretical framework indicated that participants were motivated towards STEM with a more positive expected outcome through early exposure to STEM, hands on learning, informal learning experiences, and external support. They also had a higher perceived value of STEM careers when their coursework directly related to the real-world and careers, as well as when they had a greater purpose for pursuing STEM. The findings resulted in implications for policy and practice, encouraging schools to direct attention towards working with the community to develop informal STEM learning experiences that involve parents and stakeholders in the lives of the children. Additionally, schools should adopt standards that emphasize real-world learning and engage students in content that connects to their communities and careers. In summary, this study examined the lives of students from low-income backgrounds pursuing a career in STEM from the expectancy-value theoretical foundation, with suggestions for practice that can lead towards a more equitable and diverse future in STEM.

References

A parent's guide to the SARC. (2021). California Department of Education. https://www.cde.ca.gov/ta/ac/sa/parentguide.asp

Adams, C., Chamberlin, S., Gavin, M. K., Schultz, C., Sheffield, L. J., & Subotnik, R. (2008). The STEM promise: Recognizing and developing talent and expanding opportunities for promising students of science, technology, engineering, and mathematics. *Washington, DC: National Association for Gifted Children*. http://www.ode.state.or.us/wma/stem/stem-white-paper(1).pdf

Alschuler, A., Tabor, D., & McIntyre, J. (1971). *Teaching achievement motivation: Theory and practice in psychological education.* Education Ventures.

Anderson, E., & Kim, D. (2006). *Increasing the success of minority students in science and sechnology.* American Council on Education.

Asghar, A., Ellington, R., Rice, E., Johnson, F., & Prime, G. M. (2012). Supporting STEM education in secondary science contexts. *The Interdisciplinary Journal of Problem-based Learning, 6*(2), 85–125. https://doi.org/10.7771/1541-5015.1349

Astin, A. W., & Astin, H. S. (1992). *Undergraduate science education: The impact of different college environments on the educational pipeline in the sciences.* The Higher Educational Research Institute, University of California.

Bakes, B., Goldhaber, D., Cade, W., Sullivan, K., & Dodson, M. (2018). Can UTeach? Assessing the relative effectiveness of STEM Teachers. *National Center for Analysis of Longitudinal Data in Education Research, 10*(173).

Bandura, A., & Schunk, D. H. (1981). Cultivating competence, self-efficacy, and intrinsic interest through proximal self-motivation. *Journal of Personality and Social Psychology*, *41*, 586–598. https://doi.org/10.1037/0022-3514.41.3.586

Barr, D. A., Gonzalez, M. E., & Wanat, S. F. (2008). The leaky pipeline: Factors associated with early decline in interest in premedical studies among underrepresented minority undergraduate students. *Academic Medicine, 83*(5), 503-511. https://doi.org/10.1097/ACM.0b013e31816bda16

Betancur, L., Votruba-Drzal, E., & Schunn, C. (2018). Socioeconomic gaps in science achievement. *International Journal of STEM Education, 5*(38), 1-25. https://doi.org/10.1186/s40594-018-0132-5

Bevan, B., & Michalchik, V. (2013). Where it gets interesting: Competing models of STEM learning after school. *Afterschool Matters, 17*(1), 1-8.

Boschma, J., & Brownstein, R. (2013). The concentration of poverty in American schools. *Handbook of Research in Education Finance and Policy.* https://cepa.stanford.edu/sites/default/files/reardon%20robinson-cimpian%20weathers%20HREFP%20chapter%20april2014.pdf

Bridgeland, J. M., DiLulio, J. J., Jr., & Morison, K. B. (2006). The silent epidemic: Perspectives of high school dropouts. *The Bill and Melinda Gates Foundation.* https://docs.gatesfoundation.org/Documents/thesilentepidemic3-06final.pdf

Brito, N. H., & Noble, K. G. (2014). Socioeconomic status and structural brain development. *Frontiers in Neuroscience, 8*(276), 1-12. https://doi.org/10.3389/fnins.2014.00276

Bruce, D. L. & Chiu, M. M. (2015). Composing with new technology: Teacher reflections on learning digital video. *Journal of Teacher Education, 66*(3), 272-287.

Bryan, L. A., Moore, T. J., Johnson, C. C., & Roehrig, G. H. (2015). Integrated STEM education. In C. C. Johnson, E. E. Peters-Burton, & T. J. Moore (Eds.), *STEM roadmap: A framework for integration,* (18-37). Taylor & Francis.

Bueno, E. H., Velasquez, S. M., Deil-Amen, R., & Jones, C. (2022). "That was the biggest help": The importance of familial support for science, technology, engineering, and math community college students. *Secondary Journal of Higher Education, 7*(76), 1-9. https://doi.org/10.3389/feduc.2022.768547

Burkam, D. T., & Lee, V. E. (2002). Inequality starting at the gate: Social background differences in achievement as children begin school. *University of Michigan.*

Carlone, H. B., & Johnson, A. (2007). Understanding the science experiences of successful women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching, 44*(8), 1187-1218.

Catterall, L. G. (2017). A brief history of STEM and STEAM from an inadvertent insider. *The STEAM Journal, 1*(5), 1-15. https://doi.org/10.5642/steam.20170301.05

Chemers, M. M. & Murphy, S. E. (1995). Leadership and diversity in groups and organizations. In M. M. Chemers, S. Oskap, & M.A. Costanzo (Eds.), *Diversity in organizations*, 157-188. Sage.

Chemers, M. M., Zurbiggen, E. L., Syed, M., Goza, B. K., & Bearman, S. (2011). The role of efficacy and identity in science career commitment among underrepresented minority students. *Journal of Social Issues, 67*(3), 469-491. https://doi.org/10.1111/j.1540-4560.2011.01710.x

Chen, X. (2015). STEM attrition among high-performing college students in the United States: Scope and potential causes. *Journal of Technology and Science Education*, 1-19. https://doi.org/10.3926/jotse.136

Chen, X., & Soldner, M. (2013). *STEM attrition: College students' paths into and out of STEM fields*. Statistical Analysis Report: U.S. Department of Education. https://nces.ed.gov/pubs2014/2014001rev.pdf

Chin, C., & Osborne, J. (2006). Students' questions: A potential resource for teaching and learning science. *Studies in Science Education, 44*(1), 1-39. https://doi.org/10.1080/03057260701828101

Chittum, J. R., Jones, B. D., Akalin, S., & Schram, A. B. (2017). The effects of an afterschool STEM program on students' motivation and engagement. *International Journal of STEM Education, 4*(11), 1-16. https://doi.org/10.1.186/s40594-017-0065-4

Choi, B. M. (2016). Early science learning among low-income Latino preschool children: Role of parent and teacher values, beliefs, and practices. *University of California, San Diego Open Access Publications*, 1-166.

Cohen, G. L., Garcia, J., Apfel, N., & Master, A. (2006). Reducing the racial achievement gap: A social-psychological intervention. *Science*, *313*(5791), 1307–1310. https://doi.org/10.1126/science.1128317

Cooper, R., & Heaverlo, C. (2013). Problem solving and creativity and design: What influence do they have on girls' interest in STEM subject areas? *American Journal of Engineering Education, 4*(1), 27–38.

Cotner, S., & Ballen, C. J. (2017). Can mixed assessment methods make biology classes more equitable? *PLOS One, 12*(12). https://doi.org/10.1371/journal.pone.0189610

Crisp, G., Nora, A., & Taggart, A. (2009). Student characteristics, pre-college, college, and environmental factors as predictors of majoring in and earning a STEM degree: An analysis of students attending a Hispanic serving institution. *American Educational Research Journal, 46*(4), 924-942. https://doi.org/10.3102/0002831209349460

Crotty, M. (2003). *The foundations of social research: Meaning and perspectives in the research process.* Sage Publications.

Davies, R. S., & West, R. E. (2014). Technology integration in schools. *In handbook of research on educational communications and technology* (4th ed. Pp. 841-853). Springer: New York.

Dejarnette, N. K. (2012). America's children: Providing early exposure to STEM (science, technology, engineering, and math) initiatives. *Journal of Elementary Education, 133*(1), 77-84.

Deming, J. D., & Noray, K. (2018). STEM careers and technological change. *National Bureau of Economic Research, 24*(25065), 1-67. https://doi.org/10.3386/w25065

Deslauriers, L. S., McCarty, K., Miller, K., Callaghan, K., & Kestin, G. (2019). Measuring actual learning verses feeling of learning in response to being actively engaged in the classroom. *Proc National Academy of Science USA, 116*(39), 19251-19257. https://doi.org/10.1073/pnas.182196116

Diekman, A. B., & Benson-Greenwald, T. M. (2018). Fixing STEM workforce and teacher shortages: How goal congruity can inform individuals and institutions. *Journal Policy Insights from the Behavioral and Brain Sciences, 5*(1), 11-18.

Duban, N., Aydogdu, B., & Yuksel, A. (2019). Classroom teachers' opinions on science laboratory practices. *Universal Journal of Educational Research, 7*(3), 772-780. https://doi.org/10.13189/ujer.2019.070317

English, L. D. (2016). STEM education K-12: Perspectives on integration. *International Journal of STEM Education, 3*(3). https://doi.org/10.1186/s40594-016-0036-1

English, L. D., & Gainsburg, J. (2016). Problem Solving in a 21st century mathematics curriculum. *Handbook of International Research in Mathematics Education, 3*(1), 313-335.

Forcino, F. L. (2013). The importance of a laboratory section on student learning outcomes in a university introductory earth science course. *Journal of Geoscience Education, 61*(1), 213-221. https://doi.org/10.5408/12-412.1

Gagné, F. (2011). Academic talent development and the equity issue in gifted education. *Talent Development and Excellence, 3*(1), 3–22.

Goodpaster, K. P. S., Adedokun, O. A., & Weaver, G. C. (2012). Teachers' perceptions of rural STEM teaching: Implications for rural teacher retention. *Rural Educator, 33*(3), 9–22. https://doi.org/10.35608/ruraled.v33i3.408

Grantmakers for Education. (2013). *Educating English language learners: Grantmaking strategies for closing America's other achievement gap.* https://edfunders.org/sites/default/files/Educating%20English%20Language%20Learners_April%202013.pdf

Grapin, S. E., Llosa, L., Haas, A., Groggins, M., Lee, O. (2019). Precision: Toward a meaning-centered view of language use with English learners in the content areas. *Linguistics and Education, 50*, 71-83.

Han, J., Kelley, T., & Knowles, J. G. (2021). Factors influencing student STEM learning: Self-efficacy and outcome expectancy, 21st century skills, and career awareness. *Journal for STEM Education Research, 4*(1), 117-137. https://doi.org/10.1007/s41979-021-00053-3

Hayat, A. A., Shateri, K., Amini, M., & Shokrpour, N. (2020). Relationships between academic self-efficacy, learning-related emotions, and metacognitive learning strategies with academic performance in medical students: A structural equation model. *BMC Medical Education, 20*(76), 1-11. https://doi.org/10.1186/s12909-020-01995-9

Harackiewicz, J. M., Rozek, C. S., Hulleman, C. S., & Hyde, J. S. (2012). Helping parents to motivate adolescents in mathematics and science: An experimental test of a utility value intervention. *Psychological Science 23*, 899–906. https://doi.org/10.1177/0956797611435530

Harrell, S., & Bynum, Y. (2018). Factors affecting technology integration in the classroom. *The Alabama Journal of Educational Leadership, 5*(1), 1-59.

Harris Interactive, Microsoft (2011). *STEM perceptions: Student & Parent study: Parents and students weigh in on how to inspire the next generation of doctors, scientists, software developers, and engineers.* https://news.microsoft.com/download/archived/presskits/citizenship/docs/STEMPerceptionsReport.pdf

Heyman, J. B. (2016). *Pathways into STEM among low-income, urban immigrant emergent bilingual/multilingual young adults: Opportunity, access, and persistence*. Columbia University Graduate School of Arts and Sciences. https://files.eric.ed.gov/fulltext/EJ1230212.pdf

Hill, C., Corbett, C., & Rose, A. S. (2010). *Why so Few? Women in Science, Technology, Engineering, and Mathematics.* American Association of University Women.

Hossain, M., & Robinson, M. (2012). How to motivate US students to pursue STEM (science, technology, engineering, and mathematics) careers. *US-China Education Review, 4*(1), 442-451.

Huber, C. P. (2019). *The effect of role models and real-world STEM content on 6th grade student learning and interest in a STEM career*. Sophia, the St. Catherine University repository. https://sophia.stkate.edu/cgi/viewcontent.cgi?article=1310&context=maed

Hussar, S. A., Planty, T., Snyder, K., Bianco, M., Fox, L., Frohlich, J. K., & Drake, L. (2010). *The condition of education 2010 (NCES 2010-028).* National Center for Educational Statistics: Institute of Education Sciences. https://nces.ed.gov/pubs2010/2010028.pdf

Income eligibility scales for school year 2020-21. (2021). California Department of Education (2021). https://www.cde.ca.gov/ls/nu/rs/scales2021.asp

Johnson, C. C. (2012). Implementation of STEM education policy: Challenges, progress, and lessons learned. *School of Science and Mathematics, 112*(1), 45-55.

Johri, A., & Olds, B. M. (Eds.). (2014). *Cambridge handbook of engineering education research.* Cambridge University Press.

Kent, A. M., & Giles, R. M. (2017). Preservice teachers' technology self-efficacy. *Southeastern Regional Association of Teacher Educators (SRATE) Journal, 26*(1), 9-20.

Kitchen, J. A., Sonnert, G., Sadler, P. M. (2018). The impact of college and university run high school summer programs on students' end of high school STEM career aspirations. *Science Education, 102*(3), 529-547. https://doi.org/10.1002/sce.21332

Krajcik, J., Codere, S., Dahsah, C., Bayer, R., & Mun, K. (2014). Planning instruction to meet the intent of the Next Generation Science Standards. *Journal of Science Teacher Education, 25*, 157-175. https://doi.org/10.1007/s10972-014-9383-2

Laxowski, R., & Hulleman, C. (2015). Motivation interventions in education: A meta-analytic review. *Review of Educational Research, 86*(2), 1-39. https://doi.org/10.3102/0034654315617832

Lee, O., & Stephens, A. (2020). English learners in STEM subjects: Contemporary views on STEM subjects and language with English learners. *Educational Researcher, 49*(6), 426-432. https://doi.org/10.3102/0013189X20923708

Lucas, B., Claxton, G., & Hanson, J. (2014). *Thinking like an engineer: Implications for the education system.* Royal Academy of Engineers. www.raeng.org.uk/thinkinglikeanengineer

National Academies of Sciences, Engineering, and Medicine. (2018). *English learners in STEM subjects: Transforming classrooms, schools, and lives.* The National Academies Press

Neubauer, B. E, Witkop, C. T., & Varpio, L. (2019). How phenomenology can help us learn from the experiences of others. *Perspectives on Medical Education, 8*(1), 90-97. https://doi.org/10.1007/s40037-019-0509-2

Neuman, S. B., Kaefer, T., & Pinkham, A. M. (2017). A double dose of disadvantage: Language experiences for low-income children in home and school. *Journal of Educational Psychology, 110*(1), 102-118. https://doi.org/10.1037/edu0000201

NSTA (2021). *About the next generation science standards*. NGSS@NSTA. https://ngss.nsta.org/About.aspx

Maehr, M. L., & Midgley, C. (1999). Creating optimum environments for students of diverse sociocultural backgrounds. In J. Block, S. T. Everson, & T. R. Guskey (Eds.), *Comprehensive school reform: A program perspective* (pp. 355–375). Kendall/Hunt.

Maiorca, C., Roberts, T., Jackson, C., Bush, S., Delaney, A., Mohr-Schroeder, M. J., & Soledad, S. Y. (2020). Informal learning environments and impact on interest in STEM careers. *International Journal of Science and Mathematics Education, 19*(1), 45-64. https://doi.org/10.1007/s10763-019-10038-9

Margot, K. C., & Kettler, T. (2019). Teachers' perception of STEM integration and education: A systematic literature review. *International Journal of STEM Education*, *6*(2), 1-16. https://doi.org/10.1186/s40594-018-0151-2

Martin-Hansen, L. (2018) Examining ways of meaningfully support students in STEM. *International Journal of STEM Education, 5*(53). https://doi.org/10.1186/s40594-018-0150-3

Mattern, K., Radunzel, J., & Westrick, P. (2015). *Development of STEM readiness benchmarks to assist educational and career decision making.* American College Testing.

McKenzie, K. (2019). The effects of poverty on academic achievement. *BU Journal of Graduate Studies in Education, 11*(2), 21-26.

Means, B., Wang, H., Wei, X., Iwatani, E., & Peters, V. (2018). Broadening participation in STEM college majors: Effects of attending a STEM-focused high school. *AERA Open, 4*(4), 1-17. https://doi.org/10.1177/2332858418806305

Oje, O., Adescope, O., & Oje, A. V. (2021). *Work in progress: The effects of hands-on learning on STEM students' motivation and self-efficacy: A meta-analysis.* ASEE Annual Conference.

https://rex.libraries.wsu.edu/discovery/delivery/01ALLIANCE_WSU:ResearchRepository/12353889750001842#13353889740001842

O.Nyumba, T., Wilson, K., Derrick, C. J., & Mukherjee, N. (2018). The use of focus group discussion methodology: Insights from two decades of application in conservation. *Methods in Ecology and Evolution, 9*(1), 20-32. https://doi.org/10.1111/2041-210x.12860

Ostler, E. (2012). 21st century STEM education: A tactical model for long-range success. *International Journal of Applied Science and Technology, 2*(1), 1-6.

Owens, A., Reardon, S. F., & Jencks, C. (2016). Income segregation between schools and school districts. *American Educational Research Journal, 53*(4). https://doi.org/10.3102/0002831216652772

Park, H., Byun, S., Sim, J., Han, H., Baek, Y. S. (2016). Teachers' perceptions and practices of STEAM Education in South Korea. *Eurasia Journal of Mathematics, Science & Technology Education, 12*(7), 1739-1753. https://doi.org/10.12973/Eurasia.2016.1531a

Public elementary school survey/secondary school universe survey: The share of students eligible for free and reduced lunch. (2021). National Center for Education Statistics: Common Core of Data CCD. https://nces.ed.gov/ccd/pubschuniv.asp

Purzer, S., Stroble, J., & Cardella, M. E. (Eds.). (2014). *Engineering in pre-college settings: Synthesizing research, policy, and practices.* Purdue University.

Rainey, K., Dancy, M., Mickelson, R., Stearns, E., & Moller, S. (2018). Race and gender differences in how sense of belonging influences decisions to major in STEM. *International Journal of STEM Education, 5*(10). https://doi.org/10.1186/s40594-018-0115-6

Reardon, S. F., Portilla, X. A. (2016). Recent trends in income, racial, and ethnic school. readiness gaps at kindergarten entry. *AERA Open, 2*(3), 1-18. https://doi.org/10.1177/2332858416657343

Reiser, B. J., Novak, M., McGill, T. A., & Penuel, W. R. (2021). Storyline units: An instructional model to support coherence from students' perspective. *Journal of Science Teacher Education, 32*(7), 805-829. https://doi.org/10.1080/1046560X.2021.1884784

Rennie, L., Wallace, J., & Venville, G. (2012). Exploring curriculum integration: Why integrate? *Integrating Science, Technology, Engineering, and Mathematics, 8*(2)*,* 1-11. https://doi.org/10.1186/s40594-020-00259-8

Roberts, T., Jackson, C., Mohr-Schroeder, M. J., Bush, S. B., Maiorca, C., Cavalcanti, M., Schroeder, D. C., Delaney, A., Putnam, L., & Cremeans, C. (2018). Student's perceptions of STEM learning after participating in a summer informal learning experience. *International Journal of STEM Education, 5*(1). https://doi.org/10.1186/s40594

Rozek, C. S., Ramirez, G., Fine, R. D., & Beilock, S. L. (2019). Reducing socioeconomic disparities in the STEM pipeline through student emotion regulation. *Proceedings of the National Academy of Sciences of the United States of America, 116*(5), 1553-1558. https://doi.org/10.1073/ pnas.1808589116

Salto, L. M., Riggs, M. L., De Leon, D. D., Casiano, C. A., & De Leon, M. (2014). Underrepresented minority high school and college students report STEM-pipeline sustaining gains after participating in the Loma Linda University summer health disparities research program. *PLOS One Journal, 9*(9). https://doi.org/10.1371/journal.pone.0108497

Shaughnessy, M. (2013). By way of introduction: Mathematics in a STEM context. *Mathematics Teaching in Middle School, 18*(6), 322-324.

Shaw, E. J., & Barbuti, S. (2010). Patterns of persistence in intended college major with a focus on STEM majors. *The National Academic Advising Association Journal, 30*(2), 19-34.

Sherman, D., Darwin, M. J., Song, M., Li, Y., & Satchel. S. (2015). *First-year impacts of the National Math and Science Initiatives advanced placement training and incentive program on high school students' outcomes*. American Educational Research Association. http://www.aera.net/Publications/Online-Paper-Repository/Aera-Online-Paper-Repository/Owner/616329

Shi, Q. (2017). English language learners (ELL) science, technology, engineering, math (STEM) course-taking, achievement and attainment in college. *Journal of College Access, 3*(2). https://doi.org/10.1080/26390043.2017.2091416

Silk, E. M., Higashi, R., Shoop, R., & Schunn, C. D. (2010). Designing technology activities that teach mathematics. *The Technology Teacher, 69*(4), 21-27.

Singer, A., Montgomery, G., & Schmoll, S. (2020). How to foster the formation of STEM identity: studying diversity in an authentic learning environment. *International Journal of STEM Education, 7*(57), 1-12. https://doi.org/10.1186/s40594-020-00254-z

Skinner, E. A., Kelley, S. S., Brule, H., & Williams, D. R. (2018). Science in the learning gardens: A study of students' motivation, achievement, and science identity in low-income middle schools. *International Journal of STEM Education, 5*(8).

Steele, C. M. & Aronson, J. M. (1995). Stereotype threat and the intellectual test-performance of African Americans. *Journal of Personality and Social Psychology, 69*(5), 797-811. https://doi.org/10.1037/0022-3514.69.5.797

Syed, M., Azmitia, M., & Cooper, C. R. (2011). Identity and academic success among underrepresented ethnic minorities: An interdisciplinary review and integration. *Journal of Social Issues, 67*(3), 442-468. https://doi.org/10.1111/j.1540-4560.2011.01709

United States Department of Education. (2018). *STEM course taking: Data highlights on science, technology, engineering, and mathematics course taking in our nation's public schools.* U.S. Department of Education Office for Civil Rights. https://www2.ed.gov/about/offices/list/ocr/docs/stem-course-taking.pdf

Vahidy, J. (2019). *Enhancing STEM learning through technology*. Pressbooks: Technology and the Curriculum. https://techandcurr2019.pressbooks.com/chapter/enhancingstem/

Van Haneghan, J. P., Pruet, S. A., Neal-Waltman, R., & Harlan, J. M. (2015). Teacher beliefs about motivating and teaching students to carry out engineering design challenges: some initial data. *Journal of Pre-College Engineering Education Research, 5*(2), 1–9. https://doi.org/10.7771/2157-9288.1097.

Varas, J. (2016). *The native-born STEM shortage*. American Action Forum Journal. https://www.americanactionforum.org/wp-content/uploads/2016/04/The-Native-Born-STEM-Shortage.pdf

Vasquez, J., Sneider, C., & Comer, (2013). *STEM lessons and essentials, grades 3-8: Integrating science, technology, engineering, and mathematics*. Heinemann.

Vaughn, M. G. & Witko, C. (2013). Does the amount of school choice matter for student engagement? *Social Science Journal, 50*(1), 23-33. https://doi.org/10.1016/j.soscij.2012.07.004

Verma, A. K., Mckinney, S., & Dickerson, D. L. (2011). *Engaging students in STEM careers with project-based learning.* Technology and Engineering Teacher.

https://www.researchgate.net/profile/Daniel-Dickerson-3/publication/234564900_Engaging_Students_in_STEM_Careers_with_Project-Based_Learning--MarineTech_Project/links/562f739508ae0077ccc9a190/Engaging-Students-in-STEM-Careers-with-Project-Based-Learning--MarineTech-Project.pdf

Vincent-Ruz, P., & Schunn, C. D. (2018). The nature of science identity and its role as the driver of student choice. *International Journal of STEM Education, 5*(1). https://doi.org/10.1186/s40594-018-0140-5

Vongkulluksn, V. W., Matewos, A. M., Sinatra, G. M., & Marsh, J. A. (2018). Motivational factors in makerspaces: A mixed methods study of elementary school students' situational interest, self-efficacy, and achievement emotions. *International Journal of STEM Education, 5*(1). https://doi.org/10.1186/s40594-018-0129-0

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes.* Harvard University Press.

Wang, L. (2020). *Student retention in an introductory STEM course: A mixed methods study of student motivation and teaching approaches.* Minnesota State University.

White, D. W. (2013). What is STEM Education and why is it important? *Florida Association of Teacher Educators Journal, 1*(14), 1-9.

Widya, R. R., & Rahmi, Y. L. (2019). STEM education to fulfill the 21st century demand: A literature review. *Journal of Physics, Conference Series*, 1-8. https://doi.org/10.1088/1742-6596/1317/012208

Williams, D. R., & Brown, J. D. (2012). *Learning gardens and sustainability education: Bringing schools to life and life to schools.* Routledge.

Wyss, V. L., Huelskamp, D., & Siebert, C. J. (2012). Increasing middle school student interest in STEM careers with videos of scientists. *International Journal of STEM Education, 7*(4), 501-522.

Young, J. R., Ortiz, N., & Young, J. L. (2016). STEMulating interest: A meta-analysis of the effects of out-of-school time on student STEM interest. *International Journal of Education in Mathematics Science and Technology, 5*(1), 62-74. https://doi.org/10.18404/ijemst.61149

APPENDIX A: IRB APPROVAL LETTER

Subject: [External] IRB-FY21-22-967 - Initial: Initial - Exempt
Date: Wednesday, August 10, 2022 at 12:14:22 PM Pacific Daylight Time
From: do-not-reply@cayuse.com
To: Lieu, Daniel Khanh, Rogers, Sherrita Y (Doctor of Education)
Attachments: ATT00001.png

[EXTERNAL EMAIL: Do not click any links or open attachments unless you know the sender and trust the content.]

LIBERTY UNIVERSITY
INSTITUTIONAL REVIEW BOARD

August 10, 2022

Daniel Lieu
Sherrita Rogers

Re: IRB Exemption - IRB-FY21-22-967 BARRIERS IN STUDENT MOTIVATION TO PURSUE A STEM CAREER AMONG STUDENTS FROM LOW SOCIOECONOMIC BACKGROUNDS: A TRANSCENDENTAL PHENOMENOLOGICAL STUDY

Dear Daniel Lieu, Sherrita Rogers,

The Liberty University Institutional Review Board (IRB) has reviewed your application in accordance with the Office for Human Research Protections (OHRP) and Food and Drug Administration (FDA) regulations and finds your study to be exempt from further IRB review. This means you may begin your research with the data safeguarding methods mentioned in your approved application, and no further IRB oversight is required.

Your study falls under the following exemption category, which identifies specific situations in which human participants research is exempt from the policy set forth in 45 CFR 46:104(d):

Category 2.(iii). Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least one of the following criteria is met:
The information obtained is recorded by the investigator in such a manner that the identity of the human subjects can readily be ascertained, directly or through identifiers linked to the subjects, and an IRB conducts a limited IRB review to make the determination required by §46.111(a)(7).

Your stamped consent form(s) and final versions of your study documents can be found under the Attachments tab within the Submission Details section of your study on Cayuse IRB. Your stamped consent form(s) should be copied and used to gain the consent of your research participants. If you plan to provide your consent information electronically, the contents of the attached consent document(s) should be made available without alteration.

Please note that this exemption only applies to your current research application, and any modifications to your protocol must be reported to the Liberty University IRB for verification of continued exemption status. You may report these changes by completing a modification submission through your Cayuse IRB account.

If you have any questions about this exemption or need assistance in determining whether possible modifications to your protocol would change your exemption status, please email us at irb@liberty.edu.

Sincerely,

G. Michele Baker, MA, CIP
Administrative Chair of Institutional Research
Research Ethics Office

APPENDIX B: SITE APPROVAL LETTER REQUEST

February 1, 2022

Daniel Khanh Lieu
[Redacted Address]

Dear [Redacted Prinicpal name],

As a doctoral student in the Department of Education at Liberty University, I am conducting research in fulfillment for the Doctor of Philosophy (Ph.D.) in Education: Instructional Design and Technology. The title of my dissertation is Barriers in Student Motivation to Pursue a STEM Career Among Students from Low Socioeconomic Backgrounds: A Transcendental Phenomenological Study. The purpose of this study is to study the lived experiences of students from low-income backgrounds that are choosing to pursue a career in STEM. For this study, STEM is defined as fields within science, technology, engineering, and mathematics. I am writing to request your permission to conduct my research at [Redacted School Name] within the [Redacted School District].

The data will be utilized to better understand the lived experiences of students, which include teacher interventions and student responses, positive and negative indicators of academic self-efficacy, and perceptions of STEM. Taking part in this study is completely voluntary and participants are welcome to discontinue participation in the study at any time.

I appreciate your consideration in this study. If you choose to grant permission for this study, please send a written letter of approval on official letterhead to [redacted].

Sincerely,

Daniel Khanh Lieu
Doctoral (Ph.D.) Candidate

APPENDIX C: SITE APPROVAL LETTER CONFIRMATION

[redacted]

[redacted]

April 19, 2022

Dear Daniel Lieu:

After careful review of your research proposal entitled Barriers in Student Motivation to Pursue a STEM Career Among Students from Low Socioeconomic Backgrounds: A Transcendental Phenomenological Study, we have decided to grant you permission to conduct your study at [redacted] within the [redacted]

✓ Check the following boxes, as applicable:

We grant permission for Daniel Lieu to contact Chemistry students at [redacted] to invite them to participate in his research study.

Sincerely,

[redacted]

Principal, [redacted]

APPENDIX D: COMBINED PARENTAL CONSENT AND STUDENT ASSENT

Title of the Project: Barriers in Student Motivation to Pursue a STEM Career Among Students from Low Socioeconomic Backgrounds: A Transcendental Phenomenological Study
Principal Investigator: Daniel Khanh Lieu, PhD Candidate, Liberty University

Invitation to be Part of a Research Study

Your child is invited to participate in a research study. Participants must be between the ages of 13-17 (and not turning 18 before 6/30/23), qualify for free and reduced lunch program, have completed a year of chemistry at [Redacted High School Name], must not have been a current or past student of the Principal Investigator (Daniel Lieu), and have expressed interest in pursuing a STEM career. Taking part in this research project is voluntary.

Please take time to read this entire form and ask questions before deciding whether to allow your child to take part in this research project.

What is the study about and why are we doing it?

The purpose of the study is to study the lived experiences of students that come from low socioeconomic backgrounds who intend to pursue a career in STEM and understand the barriers and motivations towards pursuing these careers. The study seeks to understand the themes within their experiences that have both motivated and dissuade them from pursuing a STEM career by affecting their expected outcome and value of these careers.

What will participants be asked to do in this study?

If you agree to allow your child to be in this study, I will ask him or her to do the following things:

1. Participate in an individual interview (one hour). The interview will be audio recorded and digitally transcribed. Participants will review the transcript after transcription for accuracy.
2. Participate in a focus group interview (one hour). The interview will be audio recorded and digitally transcribed. Participants will review the transcript after transcription for accuracy.
3. Agree to an observation (thirty-minutes) by the researcher in a STEM course. Observation notes will be taken.

How could participants or others benefit from this study?

Participants should not expect to receive a direct benefit from taking part in this study.

This study is expected to benefit society by providing an account of the experiences of students from low-income backgrounds pursuing STEM. These lived experiences provide an understanding of the barriers and motivations for students to pursue STEM, allowing educators to implement accommodations and real-world practices that can increase the number of students from low-income backgrounds in STEM.

What risks might participants experience from being in this study?

The risks involved in this study are minimal, which means they are equal to the risks you would encounter in everyday life.

How will personal information be protected?

The records of this study will be kept private. Published reports will not include any information that will make it possible to identify a subject. Research records will be stored securely, and only the researcher will have access to the records. Data collected as part of this study may be shared for use in future research studies or with other researchers. If data collected from the participants is shared, any information that could identify them, if applicable, will be removed before the data is shared.

- Participant responses will be kept confidential using pseudonyms. Interviews will be conducted in a location where others will not easily overhear the conversation.
- Data will be stored on a password-locked computer and may be used in future presentations. After three years, all electronic records will be deleted.
- Interviews/focus groups will be recorded and transcribed. Recordings will be stored on a password locked computer for three years and then erased. Only the researcher will have access to these recordings.
- Confidentiality cannot be guaranteed in focus group settings. While discouraged, other members of the focus group may share what was discussed with persons outside of the group.

Is study participation voluntary?

Participation in this study is voluntary. Your decision whether to participate will not affect your current or future relations with Liberty University. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships.

What should be done if a participant wishes to withdraw from the study?

If you choose to withdraw your child from the study or your child chooses to withdraw, please contact the researcher at the email address included in the next paragraph. Should you choose to withdraw her or him or should your child choose to withdraw, data collected from your child, apart from focus group data, will be destroyed immediately and will not be included in this study. Focus group data will not be destroyed, but your child's contributions to the focus group will not be included in the study if you choose to withdraw him or her.

Whom do you contact if you have questions or concerns about the study?

The researcher conducting this study is Daniel Lieu. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact him at [redacted]. You may also contact the researcher's faculty chair, Dr. Sherrita Rogers, at [redacted].

Whom do you contact if you have questions about rights as a research participant?

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, **you are encouraged** to contact the Institutional Review Board, 1971 University Blvd., Green Hall Ste. 2845, Lynchburg, VA 24515 or email at irb@liberty.edu.

Disclaimer: The Institutional Review Board (IRB) is tasked with ensuring that human subjects research will be conducted in an ethical manner as defined and required by federal regulations. The topics covered and viewpoints expressed or alluded to by student and faculty researchers are those of the researchers and do not necessarily reflect the official policies or positions of Liberty University

Your Consent

By signing this document, you are agreeing to allow your child to be in this study. Make sure you understand what the study is about before you sign. You will be given a copy of this document for your records. The researcher will keep a copy with the study records. If you have any questions about the study after you sign this document, you can contact the study team using the information provided above.

I have read and understood the above information. I have asked questions and have received answers. I consent to allow my child to participate in the study.

☐ The researcher has my permission to audio-record my child as part of his/her participation in this study.

____

Printed Child's/Student's Name

____

Parent's Signature Date

____

Minor's Signature Date

APPENDIX E: INITIAL RECRUITMENT LETTER

August 11, 2022

Dear [Redacted High School Name] Parent:

As a graduate student in the School of Education at Liberty University, I am conducting research as part of the requirements for a Doctor of Philosophy (PhD) degree. The purpose of my research is to understand the lived experiences, including barriers and motivations, of students from low socioeconomic backgrounds pursuing a career in STEM, and I am writing to invite your child to join my study.

Participants must be between the ages of 13-17 (and not turning 18 before 6/30/23), qualify for the free and reduced lunch program, have completed a year of chemistry at [Redacted High School Name], must not have been a current or past student of the Principal Investigator (Daniel Lieu), and have expressed interest in pursuing a STEM career. Participants, if willing, will be asked to participate in a semi-structured interview (one hour), focus group interview (one hour), and agree to be observed in a science course (thirty minutes). Names and other identifying information will be requested as part of this study, but the information will remain confidential.

To participate, please direct your child to click here to complete the participant demographic survey.

A consent document is attached as part of this recruitment email. A hard copy will be sent home with your child if the document cannot be printed. The consent document contains additional information about my research. If you choose to participate, you and your child will need to sign the consent document and return it to me at the time of the interview.

Sincerely,

Daniel Khanh Lieu
Doctoral (PhD) Candidate
[redacted email] | [redacted phone number]

APPENDIX F: FOLLOW UP RECRUITMENT LETTER

August 18, 2022

Dear [Redacted High School Name] Parent:

As a graduate student in the School of Education at Liberty University, I am conducting research as part of the requirements for a Doctor of Philosophy (PhD) degree. Last week, an email was sent to you inviting your child to participate in a research study. This follow-up email is being sent to remind you to direct your child to complete the survey if you would like them to participate and have not already done so. The deadline for participation is August 15th, 2022.

Participants, if willing, will be asked to participate in a semi-structured interview (one hour), focus group interview (one hour), and agree to be observed in a science course (thirty minutes). Names and other identifying information will be requested as part of this study, but the information will remain confidential.

To participate, please direct your child to click here to complete the participant demographic survey.

A consent document will be attached as part of this recruitment email. A hard copy will be sent home with your child if the document cannot be printed. The consent document contains additional information about my research. If you choose to participate, you and your child will need to sign the consent document and return it to me at the time of the interview.

Sincerely,

Daniel Khanh Lieu

Daniel Khanh Lieu
Doctoral (PhD) Candidate
[redacted email] | [redacted phone number]

APPENDIX G: PARTICIPANT DEMOGRAPHIC SURVEY

1. First Name

2. Last Name

3. What grade are you in?
    a. Freshman (9^{th})
    b. Sophomore (10^{th})
    c. Junior (11^{th})
    d. Senior (12^{th})

4. What is your race/ethnicity?
    a. Hispanic or Latino
    b. White
    c. Black or African American
    d. Asian
    e. Native Hawaiian or Other Pacific Islander
    f. American Indian or Alaska Native
    g. Two or more
    h. Prefer not to answer

5. What is your current age?
    a. 12 years old or younger
    b. 13 years old
    c. 14 years old
    d. 15 years old
    e. 16 years old
    f. 17 years old
    g. 18 years old or older

6. Are you interested in pursuing a STEM career?
    a. Yes
    b. No
    c. Undecided

APPENDIX H: INDIVIDUAL INTERVIEW QUESTIONS

1. Please tell me about yourself and your first experiences in STEM. CRQ
2. How would you describe your academic performance in your science classes? CRQ
3. Describe a positive learning experience in your STEM classes and what made it a positive experience. CRQ
4. What did teachers do that specifically made you feel supported or positively influenced your confidence in learning STEM? SQ1
5. Describe a negative learning experience in your STEM classes and what made it a negative experience? SQ1
6. Describe a role model that you personally know. SQ1
7. What did teachers do that specifically made you feel lack of support or negatively influenced your confidence in learning STEM? SQ1
8. What do you believe are your strengths that would help in a STEM career? SQ1
9. What is your interest level in pursuing a career in STEM? SQ2
10. What do you believe would be the expected outcome if you chose to pursue a career in STEM? SQ2
11. What value do you believe that pursuing a STEM career would or would not have in your life? SQ2
12. How do you believe that your family income, living location, and previous experiences with exposure in STEM influenced your passion to pursue or not pursue these careers? SQ2
13. What suggestions would you give to a school or teacher that would make pursuing a STEM career more appealing for you? SQ2

14. What factors influence your desire to pursue a career in STEM? SQ2

15. Describe a role that your teacher has in your decision to pursue a career in STEM. SQ2

APPENDIX I: FOCUS GROUP INTERVIEW GUIDE

1. Please provide an introduction to yourself and about your experience in STEM education. CRQ
2. What do you believe was a moment of disappointment in your STEM classes? SQ1
3. What has helped you feel successful in your STEM classes? SQ1
4. How do your experiences in your STEM classes influence your desire to pursue a career in STEM? SQ1
5. What difficulties or obstacles did you encounter in your STEM classes? SQ2
6. What do you believe was your greatest success in your STEM classes? SQ2

APPENDIX J: OBSERVATION PROTOCOL FORM

Observation Protocol	
Participant	
Date	
Time Start	
Time End	
Positive indicators of academic self-efficacy towards STEM	
Negative indicators of academic self-efficacy towards STEM	
Classroom interventions and student responses/reactions	

APPENDIX K: AUDIT TRAIL

Date	Entry: Event/Task/Update
03/26/2022	First version of manuscript sent to SOE for approval
04/23/2022	Site and district permission letter to conduct research obtained
05/20/2022	Dissertation proposal manuscript approved by SOE
06/02/2022	Dissertation proposal defense passed and approved
06/02/2022 – 08/03/2022	Revised original prospectus of chapters 1 and 2 to past tense
06/08/2022	Creation of IRB application on Cayuse
06/13/2022	Submission of preliminary IRB application
07/18/2022	IRB application returned for revision
07/21/2022	Submission of second IRB application
08/05/2022	IRB application returned for additional revision
08/05/2022	Submission of third IRB application
08/10/2022	IRB approval granted to begin research study
08/11/2022	Initiated recruitment and sent out initial email
08/18/2022	Follow up email sent out
08/12/2022 – 09/15/2022	Conducted all one-on-one interviews and observations. Focus interview conducted.
08/15/2022 – 09/22/2022	Transcribed all interviews – one-on-one and focus group interview. Interview transcription sent back to participants to allow for member checks.
09/10/2022 – 09/24/2022	All interview transcriptions received back from participants. Themes were coded. Chapter 4 completed. Revised chapter 3 to past tense. Edited chapters 1-3.
09/24/2022 – 09/28/2022	Completed chapter 5 draft. Edited/revised chapters 1-5 and submitted to Dr. Rogers for review.

APPENDIX L: SAMPLE INTERVIEW TRANSCRIPT

Transcript 10 - Fatima

Speaker 1	Hello there ___. Hope you're doing well today.
Speaker 2	I am. Thanks. You?
Speaker 1	I'm doing well too. It's been a pretty smooth day so far.
Speaker 2	Yeah same for me.
Speaker 1	Alright, we'll I'll just continue that so that we can be efficient. Thanks again for participating.
Speaker 2	No problem.
Speaker 1	For question one, can you tell me about yourself and your first experiences in STEM?
Speaker 2	My first experience being and learning in STEM would be in third grade. It was being taught during class while discussing what the acronym means, and understanding different topics such as the design process of engineering. Back then, I was considered as a shy and kind kid. As I actively listened to my teacher, sharing examples of STEM majors being offered in college, what stood out to me was computer science, life sciences, such as biology and astrobiology. I had and I'm currently still interested in other space as well as being more tech-savvy. This then led me to join an after-school program, also known as [program name]. At first, I thought was going to look super cool. As I was thinking that I would learn how to hack computers, program computers, and know all the shortcuts that's hiding behind the devices. Basically, my imagination had expectations that I would be a pro-coder or understand things like binary. It turns out that it was a platform to learn coding. Right when I got into the learning lessons from the instructor, we actually started to practice the basics on how to code out a game. After a few weeks of programming and learning more coding from

[school program name], I was then set to become a game programmer or a designer because when I was younger, I loved playing games and building games would be fun, right? No, until seventh grade, I didn't want to become a game designer because I did lots of research as well as join the [STEM learning program] to gather better insights and gather real-world experiences on what it would be like, and I wasn't really fond of it. I realized that it had a low pay for so much work.

Speaker 1 Oh wow, that sounds like you have so much experience from your teachers in STEM.

May I learn more about the [STEM learning program] and how it involved your experiences in STEM?

Speaker 2 The [STEM learning program] is a program that my school offered. I applied and I got a chance to join. They teach us more about STEM, what programs are offered, give us free tutoring, and take us on field trips.

I learned a lot about STEM from the program and it made what I learned so much more fun. I work pretty hard in school, so academically, I'm confident. When it comes to my interests though, I sometimes feel lost because there's so much going on or there's so many different career paths.

[STEM learning program] is a good addition to my academic journey.

Speaker 1 Oh okay, so that leads us into the next question actually. But it's great to hear how it supplements your academics and gives you new experiences.

Connecting it back now, how would you describe your academic performances in your science classes?

Speaker 2 When taking any science class, I would consider myself as a hard worker and would usually get high grades. If any course subject were to be my favorite, it would be science. My main interest would be science from astronomy, biology, and chemistry. In seventh grade, I was placed into a regular chemistry class and was super advanced, so the next year I was placed into honors to take on a little challenge.

Throughout junior high, I did very well as it led me to this class today. I started from biology honors, chemistry honors, and now AP chemistry in high school.

Speaker 1 Cool -- where did you get your interest in astronomy, biology, and chemistry?

Speaker 2 From the [STEM learning program] mainly. Even though the class was interesting, my love for these subjects developed as I got to experience things that related to biology, chemistry, and astronomy. I remember they took us to see a really big telescope once and we learned about the stars, the environment, and space in general.

I loved it.

Speaker 1 So so wonderfun to hear these things. I have to look more into this once this interview is over because I'd even want to join.

On a similar note, can you describe a positive learning experience in your STEM classes and what made it a positive experience?

Speaker 2 Yeah you should join if you can. Or tell your students if you teach.

Hmm… let me think about this question.

Heading onto more recent events, last year was, or last year, one of my electives was [computer science course], since I was a part of the exclusive four years cybersecurity program at ____ in the faster pace cohort known as the [cohort name] of a cohort, considering the fact that we are the first cohort of the program.

During that class, we were assigned to create technology wearables for the huge event called [class event name]. We then chose our partners and started creating our own projects. From this process, I was able to learn from my mistakes, make new ideas and ask for help whenever I felt stumped. My partner and I created a wearable camera in a shape of a power scanner from the *Dragon Ball* series, and I honestly thought it was super cool.

The wearable camera was connected to a monitor where the viewers can see from the person that's wearing it. The photos taken were saved into my Raspberry Pi, which was the base part of the wearable. I was featured on the YouTube video on the day of [event name]. That project has been selected to be used an example for future students, which I thought was amazing and really exciting that it would be shown to younger students to help them inspire them for their projects.

Speaker 1 — What aspect of the [event name] and [learning program], if I have that correctly, influenced you most as a positive experience?

Speaker 2 — It was just the inspiration and the doing that inspired me. For the [event name], I loved to create and get my hands dirty from the projects themselves.

From the [cohort name], we also get to create and work together and meet new people to create something tangible. Do you know what I mean? The interaction is really what gets me hooked and what I love.

Speaker 1 — Yes, I understand you. Thanks for sharing.

Speaker 2 — Of course.

Speaker 1 — What did teachers do that specifically made you feel supported or positively influenced your confidence in learning STEM?

Speaker 2 — I would say teachers that influenced me positively would be _____ or ____ and ____, who are teachers at ____ because they were the teachers and the program coordinators that found potential in me when I was applying to this program and got accepted to this first CS [cohort name]. Ever since then, I considered them very close and always chatted about life advice to tech.

These two teachers gave me the skills I have now, which enables me to create basic websites, how to secure my computer or someone's computer, and perform IT support. Just to name a few. The amazing part is that we are not done with this program just yet, so I'm excited to see what lies ahead.

Speaker 1	Is the [cohort name] something that is a part of your school day or would this be considered something beyond school?
Speaker 2	It's both. In school, we actually sometimes get pulled out to go to trips and sometimes, they'll rearrange our schedule to make sure that we can be enrolled in something that relates to the cohort. We also go together throughout our CS classes. It's also after school though. There's a lot of commitment after school, but it's something that I don't mind. After school is when I can really explore and not be so stressed about time and getting to my next class.
Speaker 1	Gotcha, thanks for sharing a bit more about that. Describe a negative learning experience in your STEM classes and what made it a negative experience.
Speaker 2	At first, I wanted to be a game designer, but then I noticed, or I noticed the reality of it and I decide to back out. I also found out that I didn't want to code out games constantly on a specific due date, which already gives the pressure among the programmers. I didn't have any bad experiences overall. It's probably just only when I just feel tired or confused about learning material, but overall, I overcame the challenges and I was proud of that.
Speaker 1	Can you elaborate a little more on what you mean by the reality of it?
Speaker 2	It's a lot of pressure and also I realized that for a game designer, the pay is lower than other STEM jobs. I love video games, but after learning about the pressure mainly, I realized that I wanted to do something different with my life. It's not that I don't want to work hard, but I want to make sure that I'm rewarded for the work that I do.
Speaker 1	Where did you learn about this or come to this realization?
Speaker 2	Being able to be exposed to different careers in my [cohort name]. Also, my mentors talked to me about the different career paths that I

	could take. They never discouraged me to enter the path, but they helped show me that there are better options available for me.
Speaker 1	Love that.
Speaker 2	Me too. I have a lot of great teachers here at ___ and people that I can call mentors.
Speaker 1	Focusing on those teachers, but from a different light, what did teachers do that specifically made you feel lack of support or negatively influenced your confidence in learning STEM?
Speaker 2	I don't think this applies to me because I would ask for help if I were to be in need of help. Wait, actually, back in elementary, my elementary teachers would always choose the same engineering activities, which led me not to have a big interest in engineering because throughout high school, I assumed that. We would do more the same projects as I already knew the answers, but present time, it's been going right as engineering has been more doable.
Speaker 1	Aside from more engineering activities, how do you believe that your elementary school teachers could have improved the experience in STEM for you?
Speaker 2	I don't think that they could have done anything actually. My elementary school didn't have any money to pay for cool engineering activities and I felt bad for the teachers. I know they complained about that a lot and I wish that our school could have more money to provide better educational experiences for us.
Speaker 1	Thank you for your detail in answering that. I can see how that would be a limiting factor. We've kinda touched upon this already, but what is your interest level in pursuing a career in STEM? If you're not interested in pursuing a STEM career, why?
Speaker 2	I'd say my interest level in pursuing a career in STEM is very high considering the fact that I am very interested in specifically computer science, cybersecurity, and astrobiology. Women in STEM has

	become a bigger topic nowadays, and I'm glad that I get to be one of them or at least planning to in the future. Not only this, I also want to inspire females that they're capable in pursuing a STEM-related career, despite their skin color, race, and income.
Speaker 1	Can you elaborate on how women in STEM has influenced you to pursue a STEM career?
Speaker 2	I think before, I didn't really think that STEM was for me because women don't really enter STEM. Now, being able to see other women in STEM is really inspiring to me. I like the shift that our society is heading towards.
Speaker 1	Thank you for sharing that. What suggestions would you give to a school or teacher that would make pursuing a STEM career more appealing to you?
Speaker 2	I'd say more hands-on activities, such as coding, creating projects, specifically, maybe in computer science. I'm not sure about the other parts, but I'd say teachers and mentors that would not judge on the students' mistakes and rather make a fun experience from learning from them. As I had lots of fun learning from my mistakes and laughing at myself or noticing this tiny mistake that I made in some code. I also would like to mention being outdoors would be important, or doing activities outdoors because, for example, for computer science majors, people would be on computers a lot, so being outdoors as well would be important to decrease the rates of blurry vision and focus more.
Speaker 1	What factors influenced your desire to pursue a career in STEM?
Speaker 2	My sister. My sister graduated from college with a bachelor's degree in computer science, last year, and is considered as a first-generation graduate. She's a paid intern at [company name] as a software engineer, and now working at a computer science to gather some

years of experience to seek something that speaks to her, that interests her more. I found that inspiring.

I want to do something similar as well but I want to take a little different path from it. Another person would be my dad because back in his home country he earned his bachelor's degree in engineering but when he came to the US, I don't think his degree was accepted. I wanted to show that my sister and I can be a part of STEM as we were able to get through this even though my dad couldn't use his degree in the US.

Speaker 1 Oh wow, that's such a rich story that you and your family have there.

Has your dad also influenced or motivated you to pursue STEM like seeing your sisters experience?

Speaker 2 Yeah, a bit. I think it's hard to be motivated by his story a bit more though because he did his engineering bachelor's from a different country and also, times were different back then.

Seeing my sister, it just feels closer to home.

Speaker 1 I see. We're going to shift the focus a little from your family and into

Describe the role that your teacher has in your decision to pursue a career in STEM.

Speaker 2 Mentioning ____, she would be the number one because she's a woman in STEM, and as well as Filipino, which I am a bit Filipino and 75% Mexican. We both have lots of the same interests and we both want to inspire more people to pursue careers like these because, in the future, things are going to get more advanced, and I have a feeling that other positions or jobs might be overtaken by technology.

Speaker 1 I'm glad that you had someone to connect with. It seems that a common theme between you and your sister is the connection and relation that you have.

What shared characteristics are there between your family member and teacher?

Speaker 2	They both influence me in the same way actually. My sister and the teacher that I connected with were two of the first people that I truly felt I could see myself in STEM.
	It was really inspiring to see my sister enter a STEM career and she is my role model. My teacher helps me with the connection too and I see myself in STEM, but I'll always connect to my sister more.
Speaker 1	Thank you for sharing.
Speaker 2	It's my pleasure.
Speaker 1	Well we're getting to the end here. Our last question is…
	Would you like to add anything else about your experiences in STEM and your desire to pursue a career in STEM that I did not cover in my interview questions?
Speaker 2	First, I want to say or I wanted to say thank you for allowing us to share our experiences and I'm glad that I was able to participate. Overall, I would describe my experience in STEM not bad, but more in a funky, fun, and realistic way. Thank you.
Speaker 1	No, no, thank you for sharing your experiences. You have an amazing story and I'm privileged to hear it.
Speaker 2	That's nice. Well let me know if you have anything else.
Speaker 1	Of course. I will keep you updated. I hope that you have a great day.
Speaker 2	You too, bye.