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Latinas in STEM Education: Paying it Forward

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LATINAS IN STEM EDUCATION:

PAYING IT FORWARD

A Dissertation

by

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ABSTRACT

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Hispanic female students are the minority population when it comes to taking higher level classes in the Science Technology Engineering and Math fields. According to Hinojosa, Rapaport, Jaciw, and Zacamy (2016), "STEM fields are defined here as majors in computer and information sciences, engineering and engineering technologies, biological and biomedical sciences, math and statistics, physical sciences, and science technologies" (p. 3). Traditionally, more boys enroll in STEM courses than girls. Hispanic and minority students, specifically Hispanic women, have been underrepresented in STEM education fields and careers. Why does STEM education matter for Hispanic female students? Because it gives Hispanic students in our area a chance to acquire important 21st century workforce skills such as collaboration, creativity, critical thinking, problem-solving, and communication, which will open a door of opportunity for them to escape illiteracy and poverty.

DEDICATION

The completion of my doctoral studies would not have been possible without the love and support of my family. I want to thank my mother Florencia Jimenez, my father Ramon Jimenez, who sacrificed so much for my brothers and myself. I also appreciate my husband Jesus Guillen, my daughter Brianna Guillen, and my son Jesus Guillen, all of whom wholeheartedly inspired, motivated, and supported me by all means to accomplish this degree. Thank you all for your love and patience. But above all, I thank God for helping me through all of my struggles as I embarked on the final chapter of my educational journey.

ACKNOWLEDGMENTS

I will always be grateful to Dr. Laura Jewett, chair of my dissertation committee, for all her mentoring and advice. She encouraged me to complete this process through her infinite patience and guidance. My thanks go to my dissertation committee members: Dr. James Jupp, Dr. Angela Chapman. Their advice, input and comments on my dissertation helped to ensure the quality of my intellectual work.

I would also like to thank my colleagues at the UTRGV library who helped me located supporting documents for my research. Finally, I would like to acknowledge the young Latinas who shared their life stories with me: Christina, Jacqueline, and Regina. This dissertation would be nothing if it were not for their voices and lived experiences. I am deeply grateful to have shared this experience with them.

TABLE OF CONTENTS

Page

Page

Page

LIST OF TABLES

Page

LIST OF FIGURES

Page

CHAPTER I

INTRODUCTION

This paper explored the lived experiences of first-generation Latinas who successfully navigated the Science, Technology, Engineering and Math pipeline to obtain a bachelor's degree. While some recent research has provided insight in the study of Latina's underrepresentation in STEM fields through quantitative means, my interest lies in providing the highly localized perspectives of local Latina as they navigated the STEM pipeline. This dissertation began with a qualitative inquiry into the underrepresentation of Latinas in STEM fields. I used the life history approach to explore how Latinas' lived experiences led them to obtain a degree in a STEM field and what they are doing to perpetuate this success for their Latina students who have a double bind: being a female and being Latina, while navigating the male-dominated STEM culture. Research shows that "the development of a science; technology, engineering and mathematics (STEM) identity can be thought of as a process of enhancing the way in which a student participates in the disciplinary community" (Lave, 1992, p.2). This sense of identity can empower students to feel knowledgeable and comfortable in their STEM environment" (Carlone and Johnson, 2007). This ability to recognize themselves as a STEM-interested individual can lead a student to persist within the discipline and pursue a related career. However, "Latina/o students often have difficulty developing and sustaining STEM identities and recognizing themselves as potential scientists or mathematicians, despite expressing interest in related careers" (Sorge, Newsome, and Hagerty, 2000). This is slowly

changing through efforts of Latina/o educators who help students build a positive sense of identity when it comes to STEM fields.

This study was guided by the research questions: what lived experiences have led Latinas in a Bordertown University to pursue a career in the STEM fields? and what are they doing in their STEM education fields to pay it forward and encourage Latina students to pursue a career in STEM? Scholarly literature that pertains to Latinas being historically underrepresented in STEM fields that depict several themes related to Latina's successful navigation through the STEM pipeline was discussed in Chapter 2. Chapter 3 details this study's methodological journey which design is inspired by life history methods, but is also phenomenological in some ways. I describe context and setting for the study and explain the methods that I employed for choosing participants, constructing and conducting interviews and analyzing data. I also discuss researcher subjectivity in line with my own role as both researcher and participant and what this means in terms of trustworthiness. Chapter 4 presents and discusses profiles of particpants, themes and findings. Key findings indicated that:1) Latinas' parents helped develop their STEM identity and expected them to go to college**;** 2) Latinas were motivated by challenge and that challenge was multifaceted; 3) Although Latina's STEM degree gave them a position of privilege, it also served as a way that marginalized them; and 4) Teaching in STEM education was a complicated choice, but not always a first choice. As discussed in Chapter 5, these findings can inform practitioner's work and lend insight for those involved in providing equitable resources, funding, and opportunities for future Latina's to fulfill their dream of becoming part of the STEM community. These can also be used as a springboard for additional research.

This introductory chapter focused on the background of the study, followed by a statement of the problem, purpose of the study, need for the study, research questions, significance of the

study, limitations of the study, and definitions of terms.

Background of the Study

Percentage of Latinas in STEM Careers

The Pew Research Center (2018) noted that "the majority of STEM workers in the U.S. are white (69%), followed by Asians (13%), blacks (9%) and Hispanics (7%). And while Latinas represent about 7% percent of the total workforce, they hold less than 2% of STEM occupations. Compared with their shares in the overall workforce, whites and Asians are overrepresented; blacks and Hispanics are underrepresented in the STEM workforce as a whole." Women's representation in STEM occupations varies substantially by occupational subgroup. Engineering occupations have the lowest share of women at 14%, followed by computer occupations 25%, and physical scientists 39%. However, their representation among life scientists (47%) and math workers (46%) was about the same as women's overall share in the workforce (47%). The Hispanic Heritage Foundation Report emphasized that "untapped human talent is especially great among Hispanic American females. Among Hispanics earning Bachelor's degrees in STEM fields, females earn substantially fewer than males do (36% vs. 64%). Since Hispanics will comprise almost one-third of the U.S. workforce in 2060, America's economic future depends on retaining more Hispanics – males and females – in the STEM pipeline" (p.2).

There has been an urgent call for increasing student participation in STEM fields to improve the U.S. economy. At the same time, the U.S. Latinx population has been rapidly increasing at rate of half the population growth reaching a total of 55 million in 2014 (Krogstad et al. 2015). Latinos are expected to reach 25.7% of the total U.S. population by 2050. This statistic translates to 1 in 8 Americans being Latina women (Stevenson et al., 2019, p. 973). According to the National Science Foundation (2017) women constitute 51% of the U.S. population and 56%

of total undergraduate enrollment, yet women remain underrepresented in most STEM fields. This disparity is more pronounced for people of color. Enhancing female representation from different racial and ethnic backgrounds, especially Latinas, in STEM is essential. The National Science Foundation (2017) states that "diverse ideas and perspectives are necessary to promote progress in STEM that can support our entire diverse society" (p. 2).

Stevenson et al. (2019) emphasized that Latinas face multiple obstacles when pursuing STEM degrees. Two of these obstacles include: ethnic/racial stereotypes and gender expectations that discourage them from participating in STEM. The number of women working in STEM fields has increased since 1970, but they are still "severely underrepresented in the computer and engineering fields, which make up 80% of STEM careers" (Stevenson et al., 2019, p.973). This issue has become problematic and can be seen in the workforce, where Hispanic workers represented 16% of the U.S. labor force and held 6% of science and engineering jobs, but Hispanic women only held 2% of the science and engineering occupations (NSF, 2017, p. 2).

Latina students represent a minority population when it comes to taking higher-level classes in the Science Technology Engineering and Math fields. According to Hinojosa, Rapaport, Jaciw, and Zacamy (2016), "STEM fields are defined here as majors in computer and information sciences, engineering and engineering technologies, biological and biomedical sciences, math and statistics, physical sciences, and science technologies" (p. 3). Traditionally, more boys enroll in STEM courses than girls. Martin (2016) notes that:

> Today there exists a growing wealth gap, continued poverty, and predatory English-only language policies which tend toward the restriction of women and minority participation in higher education. Gender and ethnic biases continue to relegate many women and minorities to marginal economic participation (Martin,

2016, p.97).

The U.S. Department of Education (2016) emphasized that:

> in STEM, the funding and availability of high-quality programming continues to be inconsistent…in addition, strong STEM pedagogy and resources are typically lacking in schools serving disadvantaged students, and many of the programs that are available aim to address a perceived deficit with the student, rather than focus on changing the system and delivery of STEM instruction to more effectively support and draw on students' strengths (p. 3).

Statement of the Problem

In Bordertown School District (pseudonym), 99% of our students are Hispanic and economically disadvantaged according to TEA district report card. Bordertown School District offers a STEM application and priority is given to students who have obtained "85% or above overall average in both STEM Math and STEM science classes at the end of the 1st semester" in elementary (Bordertown Middle School STEM application website). Starting at the middle school level, students are strongly encouraged to use the Middle School STEM Career Pathway to prepare and apply for Bordertown's Science Technology and Medical Professions (STAMP) Programs or STEM Programs for Aerospace and Careers in Engineering (SPACE) Academies in high school. Middle school students enroll in pre-STEM courses so that they can learn about STEM skills, pathways and careers that will be available to them when they reach high school. This process weeds out many potential female students from learning early on about STEM fields, as only a selective few are encouraged to take STEM classes in middle school. This is concerning because Fayer, Lacey, and Watson (2017) state "that the number of jobs in the STEM field will increase

23% in Texas and 17% at the national level between 2014 and 2024" (p.19). Hayden, Ouyang, Scinsky, Olsewisky, and Bielefeldt (2011) state that the National Science Board (2006) and the National Action Council for Minorities in Engineering (2008) have noted that minorities and women are underrepresented in the STEM workforce and have even emphasized this as "America's pressing challenge" and "the new American dilemma" (p. 48).

As Borman and Margolin (2017) emphasized "this discrepancy is a concern, especially in light of the projected growth in employment in STEM fields and in light of the fact that wages for jobs in STEM fields are 26 percent higher on average than wages for jobs in non-STEM fields" (p. i). These statistics are very important because 51 percent of students in Texas K-12 schools are Hispanic. Why does STEM education matter for Hispanic female students? Because it gives Hispanic students in our area a chance to acquire important 21st century workforce skills such as collaboration, creativity, critical thinking, problem-solving, and communication, which will open a door of opportunity for them to escape illiteracy and poverty. Unfortunately, because there is an underrepresentation of Hispanic students obtaining STEM degrees in our country, companies are looking for qualified talent from other countries, overlooking the tremendous untapped talent pool that we have here at home.

According to PEW Research Center, as of 2016, 17.3 million workers ages 25 and older were employed in STEM occupations. This number makes up 13% of the 131.3 million total U.S. workforce. Even though this is a small number of workers, their contributions are critical to our nation's economic innovation and productivity. Means et al. (2018) note that earning a bachelor's degree in a STEM field may lead to employment with higher lifetime earnings (p. 1). The National Science Board (2018) simultaneously emphasized that "the likelihood of earning a STEM bachelor's degree is negatively correlated with being Hispanic or Black, being female, or coming

from a low-income or immigrant family" (Means et al., 2018, p.1). This issue is especially problematic for Latinas. Therefore, Means et al. (2018) note that "attracting and retaining more women in the STEM workforce will maximize innovation, creativity and competitiveness" (p.2). Scientists and engineers are working hard to solve many of society's challenges such as finding cures for diseases like cancer and Covid-19, combatting global warming, providing clean water to people in need and harvesting energy from renewable resources. Engineers are designing products that we use in everyday life such as building bridges, cars, computers, wheelchairs and X-ray machines. These products call for a unique female perspective, which is often ignored when women are excluded from their design. Early voice recognition systems were designed using male voices only, making women's voices unheard. Hill Corbett, and St. Rose (2010) emphasize that "with a more diverse workforce, scientific and technological products, services, and solutions are likely to be better designed and more likely to represent all users" (p. 3).

Finally, our educational system has been biased against women due to hegemonic asymmetries of power produced through STEM education despite its claim to the contrary. Delgado Bernal (1998) emphasizes Giroux's question "Schools…presuppose and legitimate particular forms of history, community, and authority…The question is what and whose history, community, knowledge and voice prevails? We need to know the answers to these questions to know as teachers what we are going to teach, how we are going to do it, and how do we engage our students so that they can relate to what we're trying to teach them" (p.555). Myers (2019) notes that "Science, Technology, Engineering, and Mathematics (STEM) fields play important roles in creating knowledge for society and pathways to power, resources, and authority for scientists, yet women, and people of color, have historically been underrepresented in STEM fields" (p.648). Women have often been excluded and not given credit for participating in STEM inventions or

discoveries. Even though there have been women like Marie Curie who was a Polish physicist and performed pioneer research in radioactivity or Elizabeth Blackwell who was the first woman to graduate from medical school, we rarely hear about these female role models and their important contributions to science.

Therefore, a need to observe the experiences of first-generation Latinas who have obtained degrees in STEM program exists, and to better understand the ways they made meaning of these experiences and marshalled them to increase their determination to pursue a degree in a STEM field. The hope is that findings from this study, in-line with other research discussed in chapter 2, will help advance researchers understanding and help STEM educators better implement strategies to empower Latina students, who are inclined towards a STEM discipline, to enroll in STEM courses and obtain a career in a STEM field.

It is interesting to note that there is a STEM crisis that is more pronounced in English-speaking countries and is based on "quantitative indicators that show a declining relative performance in international comparisons of achievement and a lower rank than the nation believes it should occupy; and/or declines in participation in STEM subjects at school" (Blackley and Howell, 2015, p. 103). According to Blackley and Howell (2015), there are many organizations, such as the Organization for Economic Cooperation and Development (OECD), the World Bank, United Nations Science Education and Cultural Organization (UNESCO) that call to focus on STEM as a global initiative. This focus on STEM has sparked an educational reform in the science, technology, engineering, and mathematics disciplines and calls for more students to enroll in STEM programs (Blackley and Howell, 2015, p. 103).

Parker (2014) concured and stated that for decades the idea that science should be for "all students" has saturated science education. The term "science for all" has become synonymous

with the science education reform movement. The Goals 2000: Educate America Act and the School-to-Work Opportunities Act (1993), made scientific literacy for all American students a national priority. Almost 20 years later, A Framework for K12 Science Education: Practices, Crosscutting Concepts, and Core Ideas (National Research Council 2014) stated:

> …a compelling case can also be made that understanding science and engineering, now more than ever, is essential for every American citizen. Science, engineering, and the technologies they influence permeate every aspect of modern life. Indeed, some knowledge of science and engineering is required to engage with the major public policy issues of today as well as to make informed everyday decisions, such as selecting among alternative medical treatments or determining how to invest public funds for water supply options. In addition, understanding science and the extraordinary insights it has produced can be meaningful and relevant on a personal level, opening new worlds to explore and offering lifelong opportunities for enriching people's lives. In these contexts, learning science is important for everyone, even those who eventually choose careers in fields other than science or engineering. (National Research Council 2014, p. 7)

So, when they state "all students," who are they referring to? The American Association for the Advancement of Science Project 2061 defines all students as "those who in the past have largely been bypassed in science and mathematics education: ethnic and language minorities and girls" (American Association for the Advancement of Science 1989, p. xviii). Sharon Lynch (2000) notes that, "science education is targeting those students who have been left behind in the past—Black, Hispanics, American Indians/Alaskan Natives, female students with disabilities, and those learning English" (p. 127).

Parker (2014) emphasized that the migration of people from Central America has contributed to the fast growing Hispanic or Latino/a population in the United States. She notes that "from 2000 to 2010, the Hispanic or Latino/a population grew by 43 %—rising from 35.3 million in 2000, or 13 % of the total US population, to 50.5 million in 2010 or 16 % of the US population" (p.321). In 2020, it has grown to 62.5 million. By 2050, the U.S. Census Bureau estimates that people of Hispanic or Latino/as background will make up 102.6 million people or 24.4 % of the US population (Humes et al. 2011). The Latino/a population will encompass a great percentage of the U.S. preschool, K-12 school age, and college age populations. However, Latino/as in the US educational system does not mirror this increase in population trends. According to Chapa et al. (2006), "In 2000 Latino/a individuals accounted for 12.5 % of the total population and 17.5 % of the college-age population; however, only 10.8 % of the high school graduates were Latino/a, 9.9 % of the associate degree recipients were Latino/a, and only 6.6 % of all bachelor's degrees and 3.8 % of all doctorates were Latino/a individuals" (pp. 203).

According to the Pew Research Center (2018), "the biggest growth in women's representation since 1990 has been among STEM workers with advanced degrees, doctoral degrees in particular; this aligns with women's broader gains in educational attainment during this period. The share of women among doctoral or professional degree holders in the overall STEM workforce has climbed from 27% in 1990 to 41% today. The share of women among STEM workers with a bachelor's degree (but no advanced degree) has ticked up from 43% in 1990 to 47%, on par with the overall share of women in the workforce (47%)."

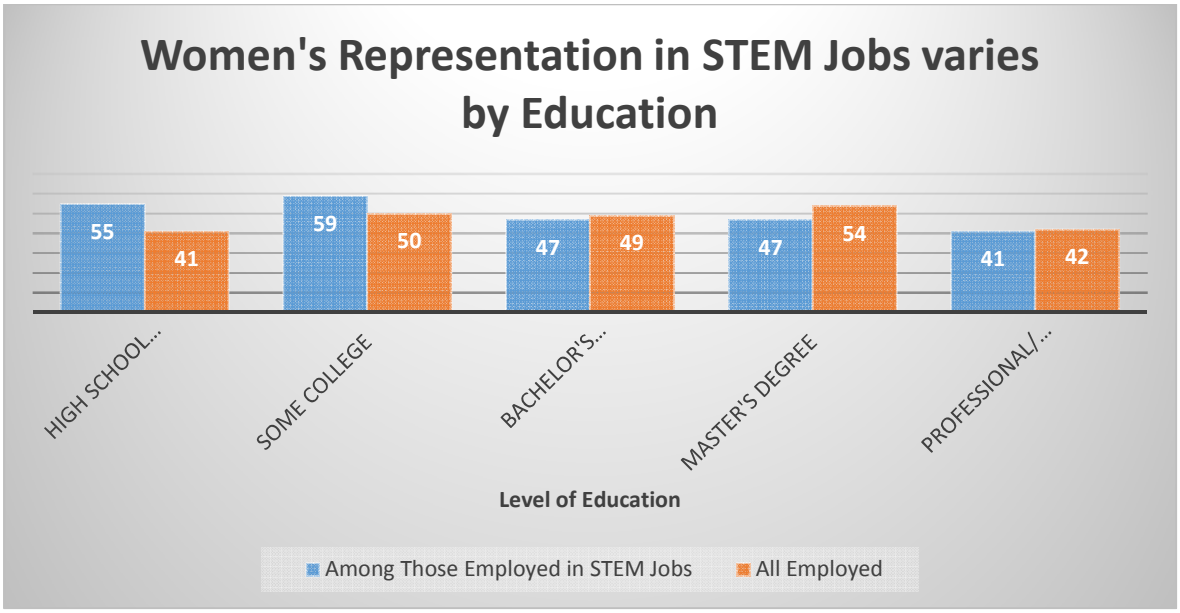

Figure 1.1 Women Representations in STEM Jobs by Education

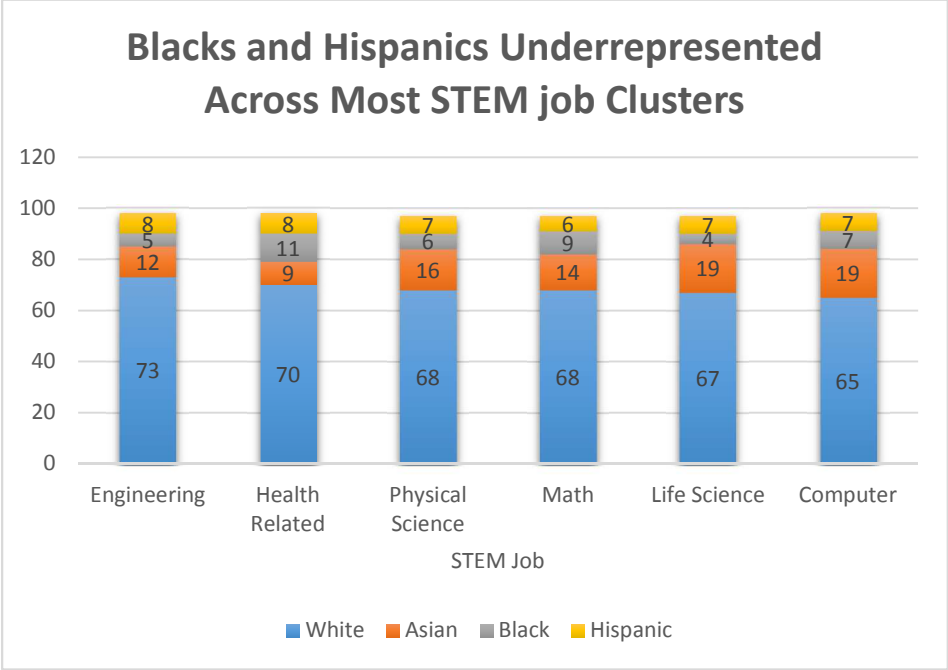

Figure 1.2 Percentage of Underrepresented Blacks and Hispanics in STEM Jobs

Parker (2014) noted that recent studies have attempted to explain disparities in achievement and participation between Latino/a students and other population groups. Flores (2011) suggested that some obstacles that Latinos/as may encounter include school curriculum and educational structural issues. School curriculum is usually not culturally relevant for Latino/as and was often tailored to white, middle-class students as the primary audience. Parker (2014) stated that

> within science, technology, engineering, and mathematics (STEM), Chapa et al. (2006) found that Latino/a students are rarely exposed to rigorous and interest provoking STEM curriculum. Moreover, K-12 schools with large Latino/a populations tend to have less rigorous science and mathematics curricula. (p.322)

Patricia Gandara (2009) found that Latino/a students were racially tracked to lower curriculum than their European American and Asian American peers.

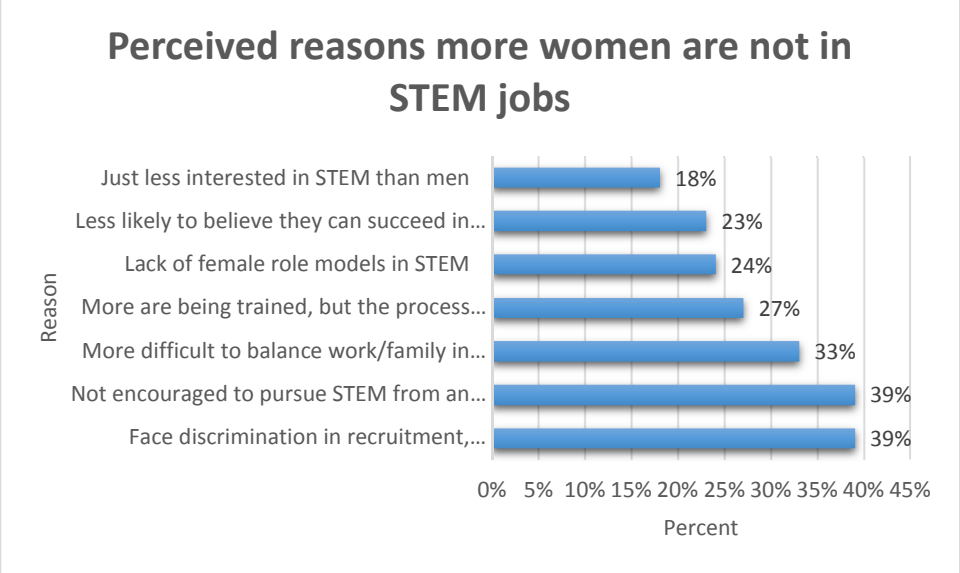

Figure 1.3 Perceived reasons more women are not in STEM jobs

Several researchers noted that we need to examine the science learning in our society, our schools, and our science classes in a deeper, more holistic level. Alejandro Gallard (2008b) in Parker (2014) believed that our science education community must understand science teaching

and learning in a more connected fashion rather than discrete disciplines. Parker (2014) stated that "specifically, in the last decade, we have not placed enough emphasis on studying how underrepresented students merge their own worlds with the worlds of school and, specifically, school science". Using Gloria Anzaldua's Chicana cultural and feminist theory, my study responds to "our need to understand the science learning of underrepresented students in a more connected fashion" (p.318).

Purpose

The purpose of this life history study was to critically explore the lived experiences of Latinas who obtained a bachelor's, master's, and are now successful STEM education professionals, particularly in science, math, and engineering education. This study also aims to recreate these experiences to motivate and encourage the next generation of Latina students to become STEM professionals. Each participant's context and perspective is unique to their lived experiences. Yet this study's interview questions were framed around what literature discusses as common features of Latina's STEM journeys: 1) cultural issues and gendered expectations these first-generation Latinas encountered growing up 2) the people who influenced, supported, or mentored these Latinas, 3) challenges and obstacles they faced as they navigated through the STEM pipeline, 4) strategies participants utilized to help them develop resilience in their quest for success in obtaining a bachelor's/graduate degree in their chosen STEM field and 5) where participants are today and what they are doing as educators to motivate and encourage future Latina STEM degree holders.

Need for the Study

While Latinas are increasingly pursuing undergraduate degrees, Latinas are still underrepresented in the overall population of STEM field graduates. As we can see from the unfavorable scenario that has been evolving, it is imperative that we take a look at a local group of Latinas who have beaten the odds and have earned a bachelor's degree in a STEM field and are now seeking to obtain a graduate or doctoral degree in a STEM education field. Using a qualitative approach, this study examined the historical, contextual, and personal lived experiences of these Latinas. This study discussed how participants' identities and roles have evolved as they pursued their degree in a male-dominated STEM field and how they are using their unique experiences to become positive role models and mentors to a new generation of Latina students on their quest for a STEM degree.

Research Questions

In order to address the purpose of this research study, I needed to think about research questions that will help me relate to these Latinas and analyze their personal and educational experiences that led them to be successful in the STEM education fields:

1) What lived experiences have led Latinas in a Bordertown University to pursue a career in the STEM fields?

2) What are they doing in their STEM education fields to pay it forward and encourage female students to pursue a career in STEM?

Significance of the Study

Access to STEM education is becoming increasingly recognized as a key driver of opportunity. The U.S. Department of Education (2016) states that "STEM education disparities threaten the nation's ability to close education poverty gaps, meet the demands of a technology

driven economy, ensure national security, and maintain preeminence in scientific research and technological innovation" (p. i).

There is a scholarly need for a life history research study to critically explore the lived experiences, that a group of Latinas who ecountered such disparity, successfully navigated it so as to obtain a bachelor's and/or master's degree, but who are now successful professionals in different STEM education fields, particularly in science, math, and engineering education, rather than the STEM fields they initially aspired to.

Findings from this study regarding Latina's STEM journeys navigating the STEM pipeline can be used to discuss new policies and procedures that educational institutions can incorporate into their STEM programs to make these students more successful. As Chapter 2 illustrates and Chapter 5's discussion of further research asserts, there needs to be even more qualitative scholarly work critically examining Latinas' experiences in STEM while focusing on the intersectionality of race, class, and gender bias that has made these women's educational journeys so difficult, yet at the same time inspiring.

Limitations

There are several limitations to note for this study. First, there were a limited amount of resources and participants. This study chose to look at the experiences of a select group of participants, and therefore the results came from purposefully selected participants who identified as first-generation Latinas who completed a bachelor's degree in STEM fields and are now educators seeking a higher education graduate or doctoral degree in STEM education. Thus, the number of participants was very selective.

Due to the scope of this research study, results from this qualitative case study cannot be generalizable to an entire population of first-generation Latina students who pursue a bachelor's

degree in a STEM field or who seek a higher education graduate or doctoral degree in a STEM education field. The life histories reported by the participants in this study have been filtered through my lens as a Latina researcher. The findings are intended to explore and better understand how Latina educators navigated the STEM fields to successfully obtain a bachelor's degree and not to generalize about the entire population of first-generation Latinas in STEM.

Definition of Terms

In this research study, some terms need to be defined in order to better understand the description of the research participants.

First-generation college student- "First-generation students are defined as those whose parents' highest level of education is a high school diploma or less." (U.S. Department of Education, 1998, p. 7)

Latina- The U.S. Office of Management and Budget defines "Hispanic or Latino" as a person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin regardless of race. (United Census Bureau, 2010)

Minority student- "a student who is an Alaska Native, American Indian, Asian-American, Black (African-American), Hispanic American, Native Hawaiian, or Pacific Islander." (U.S. Legal, 2013)

STEM fields- "majors in computer and information sciences, engineering and engineering technologies, biological and biomedical sciences, math and statistics, physical sciences, and science technologies." (Hinojosa et al., 2016, p. 3).

STEM education- "is an interdisciplinary approach to learning where rigorous academic concepts are coupled with real-world lessons as students apply science, technology, engineering, and mathematics in contexts that make connections

between school, community, work, and the global enterprise enabling the development of STEM literacy and with it the ability to compete in the new economy." (Tsupros, 2009)

Underrepresented minority student (URM)- Women, persons with disabilities, and three racial and ethnic groups—blacks, Hispanics, and American Indians or Alaska Natives—are underrepresented in Science and Engineering. (National Science Foundation)

CHAPTER II

REVIEW OF THE LITERATURE

This chapter discusses scholarly literature related to Latinas' educational journey and their engagement in a variety of STEM coursework, activities, and experiences that helped them obtain a degree in a STEM content field. The purpose of this life history study was to critically explore the lived experiences, that a group of Latinas went through to obtain a bachelor's or master's degree, and are now successful professionals in different STEM education fields, particularly in science, math, engineering and education. This study also aimed to recreate these experiences to motivate and encourage the next generation of Latina female students to become STEM professionals. This literature review begins with a brief historical narrative of STEM fields in education, then followed by Chicana feminist epistemology, as related to hegemonic asymmetries of power produced through STEM education despite its claim to the contrary. The literature was then organized into four sections which were the most common themes among the factors for achievement gaps and underrepresentation of Latinas in STEM as well as opportunities for agency and resilience as they navigated the STEM pipeline: La Familia y La Cultura, Socioeconomic Issues, Academic Preparation, and Racism/Sexism. After a review of the literature, it is evident that there is a gap in the literature about how female Latina students can be motivated and inspired to enjoy STEM experiences that will lead them to enroll in rigorous STEM courses and pursue careers in STEM fields, which will hopefully increase Latina

representation in the STEM workforce. This study was intended to fulfil this gap in the literature.

Narrative of Science, Technology, Engineering and Mathematics (STEM) in education

The purpose of this section is to explore history and the evolving importance of educating citizens in the fields of STEM in order to increase U.S. presence in the global market. This narrative is significant in that it lays the foundation for what students need to learn in order to first attain a college degree in STEM and then become productive citizens that will lead to equitable representation in the global workforce.

Societal changes influence science education curriculum aimed at giving students the knowledge, skills, and dispositions needed to become productive members of society. According to Counts (1934), "all genuinely crucial matters of the school follows the wishes of the groups or classes that actually rule society" (as quoted in Tozer et. al., 2011, p. 9). So, in line with Counts' (1934) logic, this concept would make industry an influential entity in curricular and instructional matters such as - what schools should teach, who should teach, and how the teachers will be prepared to teach our students. According to Counts (1934), in order for a change of power in educators to occur, teachers should be "permitted to fashion the curriculum and the procedures of the school they will definitely and positively influence the social attitudes, ideals, and behavior of the coming generation" (as quoted in Tozer et al., 2011, p.10). This proposal is very important proposal because we are living in an era that is ever-changing. We have advances in science, technology and machinery which have great power and enable us to live in a global society. We have shifted from the position of interest in "economics, formation of government and protection of individual liberties to interest in production, distribution, and consumption of wealth." Therefore, Counts argued for our schools to "become centers for the building of our civilization." We must give our children possibilities and hopes for what lies ahead, and we should enlist their

help in making this vision come true (Counts (1934, as quoted in Tozer et. al.,) 2011, p.10). Even though Counts wrote about this change of power in educators back in the 1930s, it is still relevant today because teachers are the single most influential factor in their students' education and by constructing knowledge together with their students in our schools, our schools are building our civilization and preparing them with skills for STEM careers that don't even exist as of today.

But what is the history behind STEM education? We begin this exploration back when there were two models of science for Elementary Schools in the late 1800's. One model was called elementary science and answered questions what does the scientific community know in specific disciplines? Francis Parker's model was used in elementary, and he wanted students to understand the universe and to use scientific techniques to solve problems. The second model was about the study of nature and asked how can science education programs contribute to students' appreciation of nature and their future role as citizens? Nature study was designed to stop migration of people from agricultural communities to urban centers. It was a way to help children become interested in farming. Science and technology played an important role in the development of an industrial society. In the late 1950s, the launch of Sputnik called for more science manpower. This is when the U.S. moved to a new space frontier. Three important structural changes occurred in 1960s: 1) focus on personal and social development declined, 2) knowledge aim became prevalent, 3) scientific methods were employed to gain knowledge. These changes brought about an objective to increase students pursuing careers in science and engineering.

According to Bybee and Pruitt (2017), a new era emerged during the 1980's due to a concern about America's low achievement on international assessment and high national security risk. In 1972, Title IX was enacted by Congress in 1972 as part of the Education Amendments, focused on ensuring that no one in the United States would be subjected to sex discrimination

under any educational program or activity receiving any type of federal financial assistance. Though best known for its influence on sports participation and scholarships, it is equally applicable to STEM participation and research supported by federal funds. On December 12, 1980, the Senate and House of Representatives assembled and passed the National Science Foundation Authorization and Science and Technology Equal Opportunities Act (Public Law 96-516) which authorized funding for activities to "to promote the full use of human resources in science and technology through a comprehensive and continuing program to increase substantially the contribution and advancement of women and minorities in scientific, professional, and technical careers, and for other purposes" (p.1).

According to Bybee and Pruitt (2017), leaders and stakeholders worried about the nation's economic competitiveness and possibility of recession and wanted students to be financially literate. Also, research that has been done on learning and the perception of the learner also call for changes in science curriculum. Bybee and Pruitt (2017) noted that there are different perspectives that emphasize different aspects of curriculum such as vocabulary, concepts, memorization, and hands-on experiences. Subject matter can be answered by the question what should students learn? The five aims that address this issue are: 1) to acquire scientific knowledge, 2) to learn the methodologies of the sciences, 3) to apply scientific knowledge and abilities to personal and 4) social contexts, and 5) to develop an awareness of scientific and technical careers (Bybee and Pruitt, 2017, p.154). There should also be "an emphasis on science curriculum in contexts of science as a way of knowing, a world view, inquiry and problem solving, all related to social and cultural issues" (Bybee and Pruitt, 2017, p.168).

According to Blackley and Howell (2015), the National Science Foundation came up with the premise of STEM in the 1990s. The acronym began as SMET, but due to negative feedback

from people, it was changed to STEM. This move towards STEM was due to "political reactionism to the potential disposition of the U.S.'s global superiority" (Blackley and Howell, 2015, p. 102). The 1983 report "A Nation at Risk" highlighted U.S. students' low math and science achievement, and reforms called for Science for All Americans (as a precursor to STEM), standards, and assessments, a change in teacher-centered curriculum to student-centered inquiry and problem-solving approaches to improve student achievement in STEM content areas. In 1990, the Louis Stokes Alliances for Minority Participation Program (LSAMP) was formed to assist universities and colleges in having a more diverse STEM workforce by increasing the number of STEM bachelor's and graduate degrees awarded to historically underrepresented groups of African Americans, Hispanic Americans, American Indians, Alaska Natives, Native Hawaiians, and Native Pacific Islanders. The program's goal is to "transform undergraduate STEM education through innovative, evidence-based recruitment and retention strategies, and relevant educational experiences in support of racial and ethnic groups historically underrepresented in STEM disciplines" (LSAMP, 1990).

This discussion highlights the importance of educating citizens in the fields of science, technology, engineering, and math in order to increase U.S. presence in the global market. This narrative is significant in that it lays the foundation for what students need to learn in order to first attain a college degree in STEM and then become productive citizens with equitable representation in the global workforce. Next, I discuss Chicana/Latina feminist epistemology.

Chicana/Latina Feminist Epistemology

The Chicana/Latina feminist epistemology is included in this literature review to highlight "the matter of concern as an important intersection for ourselves and other Chicana/ Latina feminist scholars who have centered the body (Anzaldua, 1987; Moraga, 1983a; Trujillo, 1998; Yarbro-Bejarano, 1999) through critical qualitative examinations of complex hybrid identities, epistemologies, and spiritualties, birthed from the literal and metaphorical borderlands of the United States and Mexico" (Elenes, 1997, p. 359). These critical inquiries re-center the lived experience to theorize the world in which we live in. It is "a clear departure from western, scientific, and most social science thinking. For us, theorizing the world through lived/body experience has necessitated an alternate way of communicating both socially and through critical qualitative inquiry (CQI)" (Elenes, 1997, p.359).

However, because feminism is/was mainly white middle-class perspective, other voices are/were needed to be included to address its narrow-minded focus. Chicana/Latina feminism, has been inspired by women of color, and it provides a framework that embraces multiplicity, a feminism that includes everybody. In doing so, Chicana/Latina feminist researchers have developed epistemologies and tools to redraw the cartography of research (Saavedra and Perez, 2017, p.450). These examples include considering notions of cultural, critical reflexivity, and the brown body/sexuality. From these ideas, *testimonio* has been developed to make connections between the individual "I" and the collective "we." That is, testimonio "allows for one individual to tell her story while connecting it to similar conditions across her community, whether within a national and global context, or even in privileged spaces such as academia" (Saavedra and Perez, 2017, p. 451).

La Familia y La Cultura

Delgado Bernal (2002) explored the knowledge that Chicana/Chicano students bring from their homes to help them cope with the challenges that can hinder their academic achievement and readiness for college. She studied more than 50 "counterstories" in which she notes the tools and strategies that these students use to survive in an exclusive educational system. This cultural knowledge gives students a strong foundation to combat racism, sexism, and classism. Chicana/Chicano students use their bilingualism, biculturalism, and their strong sense of community as resources to grow academically and socially. Many of these students spoke about keeping their identity through maintaining their home language. Some even rejected assimilation and held on to their culture. (p.113)

Delgado Bernal (2002) pointed out the Eurocentric epistemology and stated that there was segregation in schools for Mexicans and that their Spanish language has been de-valued. She noted that in the curriculum, we were still being colonized in our minds through referring to us as "immigrants" or foreigners who have no claim to the Americas, but that European Americans are believed to be the natural owners of this land. Therefore, our values, traditions, and beliefs are not taught in schools. This devaluing led to overcrowding of Chicana/ Chicano students in underfinanced schools. Many of our students do not graduate, and Chicana/Chicano students are overrepresented in special education classes. Thus, she looks at CRT and LatCrit lens to "unveil and explain how and why 'raced children' are overwhelmingly the recipients of low teacher expectations and are consequently tracked, placed in low-level classes and receive 'dull and boring' curriculums" (p.112). Martinez (1996) concured and stated that "my academic training taught me to place their way of knowing the social world in a sphere above my own, and this effectively silenced my

version of the story when it differed from theirs. When I didn't understand the theories of these eminent men [Marx, Durkheim, and Weber], I assumed there was something wrong with my side of the story…I had learned the story, their version very well…to the negation of my own and even my mother's" (p. 108).

Unfortunately, our schools are becoming more segregated, even within the same city. The struggles of our poor, multicultural students impact our educational goals. Martin (2016) notes that "the relationships of power are constructed, internalized, and institutionalized in the lived lives of our bicultural students" (p. 108). Gendered, poor, and marginalized students are in our classrooms and often times, as teachers, we work with the population of students we get. It is through education that students become socialized and create networks that can help them achieve equity. Many of our bilingual students have their home language and culture devalued.

Bourdieu and Passerson in Martin (2016) placed students' experiences in a language, power and capital struggle. Martin (2016) also referenced Horkheimer and Adorno who viewed the educational system as an extension of a larger social class context which considered the "capitalist system, or environment in the model, producing divisions of labor, engendering the class system, and relegating many to lower classes in socio-economic, race, ethnicity, and gender oppression" (p.100). Women and minorities function within this environment.

Delgado Bernal (2002) stated that "although students of color are holders and creators of knowledge, they often feel as if their histories, experiences, cultures and languages are devalued, misinterpreted, or omitted within the formal educational settings" (p. 106). Their families are marginalized and treated separately from school. Gandara and Hopkins stated that "Latino students who have not fully mastered English by high school have only about a 40% chance at best of completing high school and acquiring a diploma with their age mates" (Ibid, 11). However,

those students that do make it to college do so with the feelings of oppression. Two students in particular in Delgado Bernal's (2002) study, addressed "epistemological questions that deal with power, politics, and survival as well as the need for educators to recognize the knowledge, histories, and experiences of students of color" (p. 106). This literature is significant to my study because it discusses Chicano/Chicana's cultural funds of knowledge that they used to successfully navigate through high school. It also touches on language, power, and capital struggle that we, as underrepresented minorities face as we attempt to attain a STEM education. They can be seen as either barriers or assets, depending on Chicano/Chicana students' perspectives.

Gandara and Contreras (2009) noted that the Latino education crisis was not just the result of immigration. Some scholars found that on the contrary, Americanization was/is bad for immigrants. Studies have found "immigrant optimism" could be a factor that accounts for higher educational achievement of many immigrant students when compared to native born peers. Gandara and Contreras (2009) stated that "Russell Rumberger and Katherine Larson studied academic achievement among Mexican American students in a large urban school district. They found that bilingual students - generally immigrants and children of immigrants - earned better grades and accumulated more course credits that either students who were still learning English or the native-born Mexican American students. Rumberger and Larson speculated that the bilingual students simply had more social capital-access to more supportive networks-than either of the two groups" (p. 3).

A very important topic that has emerged through the review of the literature is the topic of identity. This topic can be gleamed from the narratives told by Latinas about their journey through the STEM pipeline and self-discovery about the characteristics that make them unique and successful in attaining a degree in one of these male-dominated fields. Villa et al. (2016) used

naturalistic approaches to "understand, illuminate, and interpret the multiple realities of individuals in a particular context" (p.115). He sought to answer the research question: What is the relationship among identity, resilience, and persistence of Latinas in computer science in engineering? The researchers used the theoretical framework of sociocultural theory of identity to help them understand why Latinas choose to study engineering. Villa et al. (2016) defined identity as "who we are for ourselves and in relation to others- is a complex phenomenon in which a core identity develops as we interact with others" (p.114). The study was conducted at a minority majority Hispanic university in the U.S./Mexico border in a region of Texas with the lowest median income. The researchers used purposive sampling and 26 female Latina engineering students participated in the study.

Data was collected using focused, in-depth interviewing method in which the participants reflected on their educational experiences and life histories. Three themes emerged: 1) Engineering Support Clusters as Affinity Spaces; 2) Mexican or Mexican-American Family as an Affinity Group; and 3) Equity in Access in Engineering Education. Nineteen of the twenty-six participants made references to their female identity in relation to engineering. Ten participants said that they welcomed the challenge of being rare women in the program and were proud to prove and push themselves.

These three findings were significant to my study because many Latinas, myself included, can relate to finding small groups to study for rigorous classes helped us give each other support through peer tutoring and pep talks. Family has always been important to Latinas because we are very close and depend on our families for emotional support, especially when we attended college. Yosso (2005) stated it very well when he noted that Latinx youth "learn life lessons on caring and resilience, which help them to develop emotional, moral, educational, and occupational

consciousness" (p.79). And finally having equity access in any STEM content field, makes female students believe that they can be successful in these college courses and welcome the challenge of doing as well or better than their male counterparts.

The participants in this study had the support of their family as well as of their affinity group to help them overcome barriers. Camacho and Lord (2013) in Villa et al. (2016) note that engineering education was "inflexible and pervasive" and the pre-requisites for these courses prevented students from taking electives or other courses that could improve their soft skills in the workforce. Suggestions for institutions who are seeking to increase the number of Latinas taking engineering courses are to provide physical settings for support clusters and to develop strategies to maintain family support while Latinas are far away from their families.

Winch (in Martin, 2016, p. 107) stated that people's ideas of what exists in the social world make up the social world. In order to overcome gender bias and restrictive language policies, women and minority students need more support in developing the economic, cultural and social capital that will enable them to be successful. Educational systems must be in place to increase navigational and resistance capital in order to provide equity in STEM. Women and minority populations can be recruited into STEM, but they must develop the necessary forms of cultural and social capital that will enable them to compete for jobs in STEM (Martin, 2016, p. 107).

Socioeconomic Issues

The American Psychological Association defined socioeconomic status as "the social standing or class of an individual or group. It is often measured as a combination of education, income and occupation." Socioeconomic factors and social class are "fundamental determinants of human functioning across the life span, including development, well-being, ad physical and mental health. These are all primary concerns for psychological research, practice, education,

policy, ad advocacy" (American Psychological Association Task Force on Socioeconomic Status, 2007, p. 1). Examining the socioeconomic status of individuals often reveal that there are inequalities in access to resources and can uncover issues related to privilege, power, and control.

According to the 2020 U.S. Census, the median household income was $67,521 in 2020, which showed a decrease of 2.9% from the 2019 median of $69,560. This decrease is the first significant decline in median household income since 2011. The real median earnings of all workers aged 15 and over with earnings decreased 1.2% between 2019 and 2020 from $42,065 to $41,535. The median earnings of men ($61,417) and women ($50,982) who worked full-time year-round increased by 5.6% and 6.5%, respectively. The official poverty rate in 2020 was 11.4%, up 1 percentage point from 10.5% in 2019. Between 2019 and 2020, the poverty rate increased for non-Hispanic Whites and Hispanics. Among non-Hispanic Whites 8.2% were in poverty in 2020, while Hispanics had double that poverty rate of 17.0 %. Focusing more on local data, Cameron County, the place where this study took place, the percentage of people whose income in the last 12 months is below the poverty level is 28.9%. This statistic designates our county as a high poverty area.

Gandara and Contreras (2009) referenced the 1983 report "A Nation at Risk" and stated that the nation was called to action with the warning that "if an unfriendly foreign power had attempted to impose on America the mediocre educational performance that exists today, we might well have viewed it as an act of war" (p. 2). With this, a federal commission began attempts to reform and improve schools in America. They state that "gaps in opportunity and educational outcomes are greater between racial and socioeconomic groups than when the Commission on Educational Excellence made its provocative pronouncement twenty-five years ago." Today the most urgent challenge for the American educational system has a Latino face. Latinos are the

largest and most rapidly growing ethnic minority in the country, but academically, they are lagging perilously far behind.

Gandara and Contreras (2009) questioned whether there really was an education crisis? There are a large influx of undereducated immigrants, a phenomenon that still exists today. Most people think that since previous generations of immigrants have attained a greater social and economic status than their parents, this new generation will fare the same. However, Gandara and Contreras (2009) argue that "the current data do not give cause for optimism, for they show that the demands of contemporary American society are outpacing the ability of post-immigrant generations of Latinos to overcome the educational and socioeconomic barriers they confront" (p. 2). Gandara and Contreras (2009) note that "disproportionately, the jobs held by Latino workers are low-wage and require little formal education. The strong loyalty to family among Latinos- an American value if there ever were one- can lead many to consider the opportunity costs of going to college too high" (p. 9).

Reigle-Crumb et al. (2019) stated that "scholars have directed considerable attention to disparities in educational outcomes in the fields of science, technology, engineering and mathematics (STEM)" (p. 1). The focus is part of the U.S. government's need for an increase in the number of STEM workers to "maintain the nation's economic prominence but also its status as the global leader of technological and scientific innovation" (Reigle-Crumb et al., 2019, p. 1). They use national data form the Beginning Post-Secondary Study (BPS) to investigate whether Black and Latina/o youth who begin college as a STEM major are more likely to drop out and are less likely to earn a STEM degree than their white peers. Reigle-Crumb et. al. (2019) focus on two pathways for departure: switching to another major or leaving college. They considered whether patterns of racial/ethnic departure in STEM fields differ than those in business, social

sciences, and humanities. They also considered whether racial/ethnic persistence gaps remain even after accounting for high school academic preparation.

Reigle-Crumb (2019) used the theory of categorical inequality between social groups and noted that Tilly (1997, 2000) "proposes the concept of opportunity hoarding as foundational to understanding inequality. Within the opportunity hoarding framework, members of an in-group secure and subsequently maintain access to a resource that is both limited and highly valued- one that provides an advantage at present and into the future" (p. 134). Sociologists of education note that opportunity hoarding can be see when "groups create social advantages through some form of educational segregation and thus essentially gain control of education as a highly valuable resource" (Reigle-Crumb, 2019, p.134). The opportunity being hoarded in this instance is access to equitable STEM education.

Academic Preparation

Gandara and Contreras (2009) noted that a crisis exists regarding the education of Latinos students. They state that the solution is usually to obtain "better schools, better teachers, better curriculum, schools reorganized to provide small learning communities, or other more effective organizational arrangement. They posited that The No Child Left Behind Act of 2001, which advocated testing students repeatedly and holding schools accountable, would make schools rise to the challenge and do a better job. Jupp (2006), however, draws from Pinar (2004) stating that "this dominant curriculum functions to erase differences and install a classist, racist, misogynist, and heterosexist business model" which aspires for "control of the curriculum… [and its] vicious contempt for teachers and their teachers —the educational professoriate," (p. 90). Others believe that having these students learn English as quickly as possible would close educational achievement gaps. Some even believe that if we raise our expectations for Latinos students, they

would on their own, perform at higher levels. Many who support education reform agree that the crisis can be fixed if schools have the will, resources, and talent to address the problem adequately. However, Gandara and Contreras (2009) emphasized that the crisis in Latino education goes beyond what schools can do. They stated that the "increasing failure of Latinos to achieve the American Dream is embedded in the very origins of that dream: the American mythology that everyone can make it in this country, no matter what the circumstances they encounter, if they simply work hard enough" (p. 6).

Gandara and Contreras (2009) believed that education is the single most effective way to integrate the largest growing population of Latinos into the U.S. economy and society. Therefore, if we do not reverse the high dropout rates and low educational achievement of Latino students, we will have a "permanent underclass without hope of integrating into the mainstream or realizing their potential to contribute to American society… Regardless of how they got here, Latino children are America's children and America's future" (p. 14).

Hinojosa, Rapaport, Jaciw, and Zacamy (2016) stated that STEM careers demand more education than non-STEM careers, and Hispanic students in grades K-12 are at different levels of in regards to knowledge and skills about STEM, which leads to underrepresentation in STEM workforce. Several researchers have studied the causes for these differences in the education levels between ethnic minority students and their white peers. Hispanic students have fewer resources and less qualified teachers in schools with greater numbers of minority students, lower expectations, and less representation in higher-level classes. Martin (2016) noted that "successful education of women, minorities, and the underserved requires teaching to be conducted by qualified teachers and is particularly pertinent in STEM disciplines" (p. 107). Sparapani, et al., (2014), offered a solution to improve the quality of teachers involved in the STEM program. They

proposed implementing a "global curriculum as widening one's perspective to look beyond ways in which one teaches" (p. 2). They depicted the changes and challenges of teaching and learning in the United States. Martin (2016) notes that "most countries around the world think about linguistic diversity as an asset…Global skills include a positive disposition toward cultural difference" (p. 107). Implementing a global curriculum will enable us to perform research and work on reforms and policies that will provide all students access to STEM curriculum in an equitable manner. They conclude the article with some recommendations for teacher preparation in the U.S., specifically in the areas of math, science, and technology. Hinojosa et al. (2016) recommend that the report, called "Exploring the foundations of the future STEM workforce," be used to develop "interventions that improve Hispanic students' ability and motivation" to pursue STEM degrees and careers" (p. 1).

In 2007, the publication "Rising Above the Gathering Storm" stated that the councils of the National Academy of Sciences and the National Academy of Engineering met in February 2005, discussed tensions and examined the position of the United States in today's "global knowledge-discovery enterprise." Participants were concerned about a "weakening of science and technology in the United States would inevitably degrade its social and economic conditions and in particular erode the ability of its citizens to compete for high-quality jobs" (National Academies of Sciences et al., 2007, p. ix).

McDonald (2016) emphasized that a very important reason for a decline in students' interest in math and science was the transition from primary school to high school. Students transition from a stimulating student interest learning environment to a more standards-based, content-specific, accountability focused school environment. Publications that focus on studies such as those discussed in Lyons (2006) and Renninger and Hidi (2011) have shown that students'

interest in science is positive at around age 10 and rapidly declines by age 14. According to McDonald (2016), it is during this age of rapid decline in science interest that students' mathematics learning focuses on developing algebraic reasoning which can be a gatekeeper for whether students want to pursue STEM careers. To increase engagement and interest in mathematics, students need to see the relevance of mathematics in their everyday lives, and actively participate in positive pedagogical practices.

Ostler (2012) noted that we need to define our place in a successful system by understanding various aspects of STEM success. This definition equated to understanding STEM's individual disciplines and how they are best taught at the elementary, middle and high school levels and then at the university. Milford and Tippett (2015) state that one of the major goals of education is to "establish an environment that supports an appreciation for lifelong learning; thus, an important question to raise is just what kinds of experiences within early childhood education can foster such disposition in children" (p.24). According to Milford and Tippett (2015), STEM offered at the early childhood level has the potential to "engage young children in activities that capitalize on students' interests, experiences, and prior knowledge" (p. 24). Science instruction at this level should take into consideration what children know and what they can learn, how to engage them in inquiry learning, and how to foster conceptual understanding and reasoning through scaffolding. Educators must provide experiences that build upon "students' innate interests in the natural world" which can develop positive attitudes and provide a foundation for STEM lifelong learning (Milford and Tippett, 2015, p. 25). The Milford and Tippett article is significant to my study because it emphasizes that in order for students to be successful in STEM education, they must begin engaging in STEM activities at an early age and educators need to help students transition from elementary, middle, high school, and through college by using appropriate

pedagogical strategies that promote STEM integration.

If educators follow Ostler's (2012) suggestions, Mulnix and Vandegrift (2014) stated that STEM "graduates will not only acquire content knowledge, but will also learn to engage in science as a process, effectively use quantitative reasoning, and think critically and creatively about the world. Students will understand science as an interdisciplinary and collaborative endeavor" (p.14).

In order to achieve this endeavor, "many real-world contexts and problems typically involve more than one of the disciplines. For example, designing alternative energy systems that run on solar or wind energy, understanding how to maintain a clean water supply or maintaining fragile ecosystems will require knowledge and practices from across the STEM disciplines" (National Research Council, 2014, p. 20). Another example that advocates for integrative STEM education, "scientists use technological tools to conduct experiments and mathematics and statistics to interpret the data produced by those experiments; engineers draw on scientific knowledge and mathematical reasoning to develop and model potential design inventions and solutions; technologists who build and maintain the products and systems designed by engineers must understand the scientific and mathematical principles governing their operation" (p.20). Scientists and engineers that work for companies, academic institutions, or government laboratories work in ways that integrate the disciplines of STEM.

Racism/Sexism

Education scholars who have used Tilly's (2007) work argue that "in contemporary times, one of the primary and most powerful mechanisms through which the in-group creates and maintains such advantages is the construction and perpetuation of stereotyped assumptions and beliefs regarding the attributes of members of the out-group, which are the used to justify their exclusion" (Riegle-Crumb et al., 2019, p. 134). Other studies point to hoarding of educational

resources in high schools, where privileged youth are often disproportionately represented in the most advanced academic classes (Kelly, 2009; Kelly and Price, 2011; Lewis and Diamond, 2015; Lewis-McCoy, 2014) (Reigle-Crumb et al., 2019, p. 134).

In their study, Riegle-Crumb et al. (2019) considered STEM postsecondary fields as a site of racial/ethnic opportunity hoarding among those who successfully register for college classes. As STEM fields are "highly esteemed and perceived as economically prosperous, we argue that they stand out amidst potential college majors as a highly valuable resource that leverages tangible earning and status potential" (p. 134). Therefore, earning a STEM degree is a highly valued opportunity. Tilly (2007) notes that "scientific-technical knowledge is increasingly important- looming larger by the day as an inequality-generating resource- contributing to a categorical distinction between scientists and non-scientists" (p. 252).

Riegle-Crumb (2019) emphasized that empirical literature was limited but provides some evidence of racial/ethnic gaps in STEM degree persistence. The researchers found that "beginning with STEM majors, in the baseline model, we see that compared to their White peers, both Black and Latina/o students have significantly higher possibilities of switching out of a STEM major and completing a degree in a non-STEM field than persisting and earning a STEM degree" (p. 141). Riegle-Crumb (2019) noted that STEM is the only field where Black and Latina/o youth are significantly more likely than their White peers to switch and earn a degree in another field and for Latin/o students, this difference is explained by social class background.

Riegle-Crumb et. al (2019) emphasized that past qualitative research does support the case that STEM degree and college classrooms are purposively constructed as exclusionary spaces where students must essentially prove that they deserve to stay (Beasley 2011; Seymour and Hewitt, 1997). They also noted that "while such spaces are challenging to navigate for most

students, minority students experience these spaces while subjected to specific stereotypes about their presumed inferior cognitive and mathematical ability." This research led many to believe that stereotype threat was very high. The theory of opportunity hoarding highlighted "the role of stereotypes as a key factor through which the in-group creates and maintains privilege, particularly in contemporary times when 'egalitarian norms have forced boundary practices underground, to unconscious cognitive processes'" (p. 142). This causes micro-aggressions and a lack of support and inclusion by some faculty members and pre-dominantly White classmates. This also contributes to minority students' experiences and feeling of exclusion which are linked to the hoarding of STEM degrees among White students.

STEM Education Pipeline

King (2016) discussed the STEM education pipeline and noted that more females than males "leak" from the STEM pipeline at several key points in their lives, specifically in college. Griffiths et al. (2020) agrees and notes that persistence of women in STEM is much lower and thus suggests leads to the leak in the pipeline. Seymour and Hewitt (1997) concur and found that based on a student sample with high scores from seven universities, women tend to drop from STEM majors more than men. Chen (2009) further emphasized that about 45% to 50% of students who enroll in STEM courses do not finish with a STEM degree. Past research notes that there are several factors for this occurrence. One may be the culture present in many introductory math and science courses that intend to weed out students through lectures, competitive environments, and assignment of low grades. Hall and Sandler (1982) also suggested that there also existed a "chilly climate" towards women in the classroom, such as differential treatment, encouraging women to switch majors, devaluing their intellectual abilities, and calling on males more often to answer. Moss-Racussin et al. (2012) conducted a study where science faculty rated students' applications

for employment as a lab manager and found that males students were rated higher than female students despite the fact that their applications were identical. This fact makes female students feel at a disadvantage and lowers their persistence rates in STEM.

King (2016) used data from BPS:04/09 which was a nationally representative study that followed students throughout their college years to investigate gender differences and persistence rates of students who major in STEM. There were 1,694 students whose initial college major was in STEM fields. They were interviewed at the end of the 2003-2004 academic school year and then follow up surveys were conducted in 2006 and in 2009. The outcome of the study measures whether a student persists within their field and earn a bachelor's degree. The study found that 34.8% of males and 37.7% of females did earn a STEM degree within 6 years. Although the results show that women have about the same rate of persistence in STEM than men, King (2016) notes that "it may still be the case that women face obstacles that are not present for male students, but perhaps the women who choose to enter STEM fields are particularly resilient to such obstacles" (p.8). King (2016) advises to focus on occurrences in the STEM pipeline where there is gender equality and use the information to develop programs and policies that will recruit women into STEM by "targeting students before entering college as well as work to help women who earn a STEM bachelor's degree transition into the STEM workforce" (p.9). This concurs with Chapman et al.'s (2019) findings which "not only emphasize the need for informal STEM experiences that promote participation for all students, but also changes to K-12 preparation programs and professional development" (p. 12).

STEM Workforce

Griffiths et al. (2020) stated that historically, women have been treated unequally both in education and in the workforce. Martinez and Christnacht (2021) noted that women make up

nearly half of the U.S. workforce, but are still underrepresented in the STEM workforce. Women made gains, from 8% of STEM workers in 1970 up to 27% in 2019. However, men still dominated the STEM field. A disproportion in STEM can be seen in 2019, where men occupied 73% of STEM jobs, even though job distribution seemed to be more equal, 52% men and 48% women. The Society of Women Engineers (2018) noted that although the gap between boys and girls completing STEM courses in high school has been decreasing over the past 30 years, only 9.5% of female freshmen pursued STEM majors as opposed to 27.9% of males. In addition, 32% of women changed STEM majors and only 30% of women who did earn a bachelor's degree in engineering continued to work in the engineering field 20 years later. Furthermore, reports state that women in STEM account for 13% of engineers, 26% of computer scientists, 17% of tenured engineering faculty and 28.4% of science and engineering occupations (Griffiths et al.,2020, p. 294). Griffiths et al. (2020) emphasize that "the absence of women in the workforce and education has a substantial impact on equitable opportunities and economic growth overall" (p.294).

Griffiths et al. (2020) emphasized that it was very important to facilitate collaboration among team members in girls' homes, schools, and future workforce settings to make appropriate changes across levels and systems. Team members need to be more aware and mindful about planning and matching student interests and goals with "appropriate curriculum and resources to increase diversity" (p. 295). Griffiths et al. (2020) state that "when addressing the critical points of interventions for preparing girls in STEM, we propose intervening at the following systems levels: (a) individual, (b) preschool through 12th grade, (c) higher education, and (d) employment, each uniquely influenced by home, community, cultural systems" (p.295).

Griffiths et al. (2020) proposed that educators gather data about the labor market and use this data to develop interventions that will provide appropriate preparation and skills training. The

interventions can be used to "enhance STEM employment and engagement outcomes for historically underserved individuals. The FACES framework represents the many faces of diversity" and include Facilitation, Awareness, Connection, Exposure, and Support (p. 297).

First, Griffiths et al. (2020) noted that facilitating effective collaboration could be used to attain positive outcomes which provide equitable educational opportunities. Having a collaborative team, opens communication and helps team develop shared goals for the future. This process can be started at the elementary level by teaching students work-related behaviors like social skills, problem-solving, and following directions. Educators can teach students these skills so that they prepare their students for a world that is always evolving. Next, Griffiths et al. (2020) note that awareness of the need for girls and women with disabilities to be included in STEM fields is also important. They can offer a unique perspective that can have a positive influence in STEM fields. Following this, educators need to make connections by "creating opportunities for girls to understand the relationship between their current STEM learning and their professional and personal aspirations in the future." This preparation can be done through training, internships, and mentorships with educators and STEM-related professionals. Girls can then see that "success and fulfillment in STEM careers are a real possibility" (p.298). Finally, Griffiths et al. (2020) propose offering female students "support based on the needs of the individual, in the context of the subject matter and occurs early and often in STEM education and professional settings" (p. 299).

Summary of Chapter

In this section, we explored a brief narrative of STEM fields in education. Then we explained the Chicana Feminist epistemology which was used to explore Latina's way of thinking about their lived experiences. We discussed literature relating to most common themes among the factors for achievement gaps and underrepresentation of Latinas in STEM as well as opportunities for agency and resilience as they navigated the STEM pipeline: La Familia y La Cultura, Socioeconomic Issues, Academic Preparation, and Racism/Sexism. We navigated through the STEM pipeline and found that many women exit the pipeline at different times due to culture in many math and science courses, chilly climates in the classroom, and faculty bias. King (2016), however, noted that there are occurrences of gender equality and that we must focus on targeting students through interventions before they begin college. This literature is significant to my study because it provides insight as to the obstacles and barriers that Latina/os encounter as they navigate the STEM pipeline as students. It also provideds insight as to how we, as educators, can engage students in STEM content and motivate them to enroll in STEM courses. The next chapter presents the methodology for this qualitative research study examining the experiences of successful, first-generation Latinas in the STEM fields.

CHAPTER III

METHODOLOGY

This narrative inquiry into Latina female educators in STEM fields, evolved from my lived experiences and utilizes a life history approach. As I went through this critical inquiry, I thought about my own story and offer my researcher positionality to introduce my perspective as a researcher, as well as a participant in this study. A discussion of the background of the life history approach introduced definitions, an overview, a distinction between a life history and narrative, distinct attributes of life history and my rationale for using a life history approach for this critical inquiry. This discussion was then followed by the research design for the study. Participants for this study were selected from Bordertown school district using purposive sampling technique. Data was gathered through the use of interviews, artifacts, researcher journals, and peer debriefings. Data was then analyzed and patterns were identified and explored from the lived experiences of these Hispanic female educators and themes were developed that show similarities and differences between and among these educators as they successfully navigated the STEM education pipeline. The use triangulation of all data sources enhanced the validity and reliability of the study to ensure credibility in the implementation of the life history methodology.

Researcher Positionality

We all ask questions from ourselves and others. Hancock and Algozzine (2017) note that we are all researchers, because research involves looking for answers to questions that help us

understand the world we live in. Cole and Knowles (2001) quote sociologist Schwalbe (1995) as saying "it could be that all my studies of other people are partly a roundabout way to know myself better. The autobiographical and the relational, then are two qualities central to our life history research orientation" (p. 10). Jupp (2013) notes that "the choice of reflexively studying my own identifications adds to a growing body of research that seeks equitable social relations in which researcher and respondents come from and represent the same groups" (p. 147).

I decided to pursue this topic for my dissertation after I read the book *Paths to Discovery: Testimonios by Chicanas in STEM*. I related to Cantu's (2012) story where she states that:

> I think of the young Chicana student brimming with curiosity, with a desire to know how the world works, wanting to be a scientist, a Chicana sitting in classrooms without competent teachers or with poor facilities or without an encouraging word from anyone. In the future, she could be traveling to Mars, engaged in medical discoveries or even be the one to push science to the next revolution. But she may never get to do any of these things if none nurtures their scientific spirit or gives her the solid preparation it will take to succeed in college. (p. 473)

As a researcher, I brought my own personal experiences and funds of knowledge into this narrative inquiry. The legacies that have informed my positionality have been my family and my teachers at school. I presented my life story, so that my participants could know about my lived experiences and so that they would be able to share their life stories, and together we could discern what helped us succeed in our respective STEM education fields and note what lived experiences, strategies, and resources we can reconstruct in our educational settings to make a difference in our little corner of the world. I am a Hispanic woman who became interested in math and science at a very early age. I know that many students do not like math, but somehow, I enjoyed math

because it seemed to me that I was always solving puzzles. My parents always had high expectations for me because I was the oldest and the only female out of my siblings, which include three brothers. Even though my parents did not have an education beyond the elementary level, they always wanted me to have a better life than they had. My mom would always tell me that I had to obtain an excellent education in case I got married to someone who would not provide enough for our family, or if I ever found myself alone and with children. Well, I took this to heart. But even though my passion is for math and science, I believe that my 3rd grade teacher in elementary instilled in me the love of books. I have always enjoyed reading and that made a whole lot of difference in how I understood the math and science language, enough to excel in both. In high school, I was invited to attend a STEM camp at Texas Southmost College. When I was 16 years old, I got my first college identification card and learned about Boolean Algebra, Electrical Engineering, and some computer language. I was fascinated! However, it was very intimidating because the majority of the participants were boys. I loved learning at the university through hands-on experiences and with like-minded people as myself. I knew right then and there that I would eventually come back to become a student at the college, which later became UTB.

Well time passed, and my daughter went to high school and was invited to a STARGATE camp at UTRGV when she was 16 years old. She was hesitant to attend because she wanted to have fun with her friends and go to the pool or to the movies instead for the summer. But I shared my TEX-Prep experience with her and she agreed to go and told her that it would look good on her resume when she applied to colleges. Although she said it was difficult to go to the university in the summer, she thought it was well worth it. She learned about astronomy, physics, calculus, satellites, and actually got to work on a research project. Since my mom had high expectations for me, I have even higher expectations from my daughter. She is my only girl and has a brother who

looks up to her. I have noticed that both my children excel at math and science. My daughter, in particular, understands science very well, enough to want to pursue a degree in the medical field. However, in order to do this, she must have a great science and math foundation. She is currently in her first year of medical school.

I decided to embark in this research study because I have a personal commitment as a parent to my children who are Latinos and to the children in the schools that I have had the privilege to work for as an advocate for their education and to have high standards for them, especially in the areas of science, technology, engineering and math. Now as a researcher, I am looking at the underrepresentation of Latinas in STEM through several different perspectives: as a parent, a teacher, an administrator, a researcher. I hope that through this research, I can gain insight and strategies that may help me inspire and motivate more Latinas in my community to pursue an education in a STEM field.

Background Life History Approach

Definitions and overview

The research design used to address these research questions is life history design. Life history methodology is defined as "an extensive autobiographical narrative, in either oral or written form, that covers all or most of a life...life history can also refer to a social science text that presents a person's biography" and can emphasize a specific facet of a person's life (Chase, 2005, p.652). Life history has also been defined as "a narrative approach in which empirical methods are used to reconstruct and interpret the lives of ordinary persons" (p.652). Life history can be used to help us understand "how particular people experience and adapt to major life events." As Schempp (1995) states "the life is seen as being lived in a time, place under particular circumstances rather than a simple collection of events" (McKay, 2000, p. 115).

However, the definition that is guiding the design for this study is the one used by Cole and Knowles (2001). It states that life history inquiry is "a representation of human experience that draws in viewers or readers to the interpretive process and invites them to make meaning and form judgments based on their own reading of the 'text' as it is viewed through the lenses of their own realities" (p.11). The life history researcher, therefore, serves as a "central instrument, the prime viewing lens" (p.10). This method was chosen to gain insight into and to comprehend the lives of Latinas who successfully obtained a degree in a STEM field and are paying it forward with our Latina female students in our Bordertown school districts. The life history approach "allowed for a detailed exploration of each woman's lived experience enabling the unique diversity of her life to be understood and represented" (McKay, 2000, p.115).

Life historians believe that the stories people tell about their lives can provide "essential insights and can answer big questions and the responses can have implications that they can have to any facet of social life (Erben, 1998a, 1)" (Chase, 2005, p.562).

Life history as distinct form of narrative

Cole and Knowles (2001) stated that life history "acknowledges not only that personal, social, temporal, and contextual influences facilitate understanding of lives and phenomena being explored, but also that, from conceptualization through to representation and communication of new understandings to others any research project is an expression of the elements of a researcher's life history" (p. 10). In contrast, a narrative method in research "is based on the assumption that human experience is episodically ordered and best understood through a reconstruction of the natural narrative order in which it is lived. Significance is given to the personal, temporal, and contextual quality of connections and relationships that honor the complexities of a life lived as a unified whole" (Cole and Knowles, 2001, p. 19). The focus is on the individual and that "life can

be understood through a reconstruction of the life story" (p.19). Cole and Knowles (2001) emphasize that "whereas narrative research focuses on making meaning of individuals' experiences, life history research draws on individuals' experiences to make broader contextual meaning" (p.20). Significant historical events give meaning to a participant's life, which is composed of many rich layers of contextual influences (cultural, political, familial, educational, religious, etc.).

Cole and Knowles (2001) state that the unique attributes of life history are:

- Life history inquiry is about gaining insights into the broader human condition by coming to know and understand the experiences of other humans.
- It is understanding a situation, profession, condition or institution through coming to know how individuals walk, talk, live, and work within that particular context.
- It is about understanding the relationship, the complex interaction, between life and context, self and place.
- It is about comprehending the complexities of a person's day-to-day decision making and the ultimate consequences that play out in that life so that insights into broader, collective experience may be achieved.
- Lives are understood within their respective and collective contexts, and it is this understanding that is theorized (Cole and Knowles, 2001, p. 11).

History of life history method

Plummer (1983) in Miller (2000) states that "the first author to turn life history into an object to be theorized by the human sciences was Dilthey (1833-1911), who viewed 'life story as

a whole, an object complete unto itself". To analyze the object and grasp the significance of life experience in its singularity Dilthey developed the 'comprehensive method', based on empathy, later to be reconsidered and defined by Weber" (p.4). Miller (2000) notes that Dilthey's concern with "life and lived experience" was one of the European influences that affected Robert Park of the first Department of Sociology in the United States at the University of Chicago. Since then, sociologists as well as other scholars interested in humanities have implemented these methods. Ojermark (2007) notes that life history research has its strongest roots in sociology.

The "Chicago School" refers to a group of sociologists from the University of Chicago whose way of thinking about social relations was "heavily qualitative, rigorous in data analysis, and focused on the city as a social laboratory" (Lutters and Ackermann, 1996, p. 2). The authors note that "the exploration of cross-cultural social adjustments, both internal and external, became a hallmark of 'Chicago School' studies and a cornerstone for urban sociology" (Lutters and Ackermann, 1996, p.8). The use of the life history technique can be seen in "the 300-page life story of Waldeck Wisznienski, a Polish immigrant to America, which formed a central part of The Polish Peasant in Europe and America study of W.I. Thomas and Florian Znaniecki" (Miller, 2000, p.4). Many Chicago School researchers explored the effects of this transition on all aspects of social life. This research led to more high-level discussions of "cultural accommodation versus assimilation of specific immigrant populations". A salient but interesting theme came about from the exploration of factors that "promote stability and maintenance of community in the midst of disorganization." What allowed for some groups to safely come through the transition better than others? The researchers found that "the effects of disorganization are mitigated only by the degree to which there are stable constants in the transition. For Thomas' Polish immigrants, it was the local parish church and the maintenance of many tightly-bound communal living practices"

(Lutters and Ackermann, 1996, p.6). This resounding theme of the studies is discussed in chapter 2 of this dissertation I have read about Latinas in STEM content areas.

Cole and Knowles (2001) used life history research in a study of teacher education professors. Their attention was drawn to the many obstacles "faced by those who, in subtle and more overt ways, attempt to challenge the status quo of and within their academic institutions" (p. 23). They discuss their experiences which paint a picture of individuals trying to make a difference through the work they do as teacher educators. The stories and struggles these educators face are more pronounced when placed within the context of the academy as a social institution. Women in the study "received subtle and not-so-subtle reminders of her 'proper' place in the male-defined hierarchy of her institution" (Cole and Knowles, 2001, p. 23). Goodson and Sikes (2001) note that feminist researchers also use life history due to the way "in which it can be used to give expression to, and celebration of, hidden or 'silenced' lives: lives which are lived privately and without public accomplishments- the sorts of lives most women (and it has to be said, most men) live" (p. 10). Munro (1998), cautions that life histories are not neat chronological accounts of women's lives, which would be a distortion designed to fit in nice "categories and cultural norms of patriarchy" but life history does need to "attend to the silences as well as what is said, that we need to attend to how the story is told or not told, and to attend to the tensions and contradictions rather than succumb to the temptation to gloss over these in our desire for 'the story'" (p.12). These authors implement life history to examine women's lives in various contexts and to give them a voice. Goodson (1995, 98) in Cole and Knowles (2001) note that life history research represents "stories of action within theories of context" (p.13).

Life History Research Design

I found the perfect rationale for using this methodology after I read *Lives in Context* and their consequences…All of these qualities make it a life history account (Cole & Knowles, 2001, p. 3). This research design is appropriate to my research questions because as my participants recount their life histories, I can understand what backgrounds, motivations, and lived experiences have led Latinas in a Bordertown University to pursue a career in the STEM fields. This study of my participants' life histories can give me insights of how these group of Latinas overcame obstacles and challenges and became successful in their pursuit of a degree in a STEM field. This can also help me gain insight into how they are paying it forward to encourage other Latina students to pursue a career in STEM as well.

Participants and Setting

The "narrative turn" of life history advocates for "political action with, and on behalf of, vulnerable groups." Feminist scholars use this method to "uncover the diversity of women's experiences and to project women's voices into areas where they have previously been ignored" (Cole & Knowles, 2001, p.2). I implemented a life history study because I wanted to gain a better understanding of the diversity of experiences Latinas who have majored in a STEM education field and are paying it forward by inspiring young Latina students to pursue careers in STEM fields.

I used purposive sampling, which is based on the characteristics of a population and the objective of the study. Purposive sampling is widely used in qualitative research for the identification and selection of information-rich cases related to the phenomenon of interest (Hancock and Algozzine, 2017, p. 72). For the purposive sampling, participants in this study fit the following criteria:

1) Being a Latina: they identify with being Hispanic/Latina due to the language they speak or their ancestors spoke. They share a common culture.

2) Completed a degree in a STEM field: participants obtained a bachelor's degree in science, technology, engineering, or math.

3) Are educators and work with Hispanic students: work for a South Texas school district.

4) Have worked with Hispanic students in a STEM discipline for at least 4 years: to show experience and commitment working with students in our area.

The selection criteria was based on my literature review which states that Latinas are underrepresented in STEM fields, and there is a low enrollment of Latina students in STEM courses at the secondary level.

I began searching for this purposive sample by screening participants that fit these criteria. All participants from the snowball sample work as educators in Bordertown schools, and most of their students were labeled as "minority," "low socio-economic," "economically disadvantaged," "at risk," or performed at "below grade level."

All teachers and their schools were given pseudonyms to protect their identity and maintain confidentiality. I looked through Bordertown school districts' websites searching for Latinas currently teaching a STEM course. Since I have been working with Bordertown school districts for over 20 years, I have met several potential candidates that fit the criteria for my study. I then proceeded to send all of my potential participants an email to request their participation in my study.

Data Gathering

I gathered data through interviews, artifacts, and my research journal for this study.

Interviews

I met with three participants in three rounds of interviews followed by a session for member checking. These interviews took place during from January - December 2021. I, as the researcher, included myself as the 4th participant. Due to Covid pandemic restrictions, these interviews were done through Zoom meetings.

I conducted the interviews in 3 sessions. Each session lasted about 90 minutes. Before the first session began, I asked my first participant to choose 3-5 artifacts (they can be pictures, video clips, letters, or books) that reminded them of pivotal instances in their STEM journey as a student to bring to our first interview session. Lincoln and Denzin (1998) view these materials as "mute evidence- that is, written texts and cultural artifacts- endures physically and leaves its traces on the past." These materials obviously do not literally speak, but when we interpret them "important meanings are found about the past and the human shape of lived cultures" (p. 38). This material culture is the past being reconstructed socially and represented in present times.

For the 1st interview, I informed my participant that I would be recording the interview so that I could transcribe the interview as accurately as possible. When we actually met through Zoom, I asked my participant to show me the objects that they chose for our first session. I then asked them what these objects represented for them and used them as talking points to guide our discussion. I recorded the interview and listened carefully so that I could become familiar with my participant. The recording helped me remember gestures or things that had an affective impact on my participant, something that could not happen with just transcription. I took notes in my researcher's journal during the interview. I concluded the first session by engaging my participant in member checking and asking them for a time and date for the 2nd session and leading them into

our second interview session topic. Once the time and date were determined, I asked them to bring 3-5 artifacts that remind them of pivotal instances as teachers or educators in a different professional capacity to our next meeting.

For the 2nd interview, I asked my participant to show me the objects they chose to signify their pivotal instances in their STEM journey as an educator, and those objects were the talking points for our second session. I recorded the interview and listened carefully so that I could transcribe the interview as accurately and as vividly as possible. Again, I noted the setting that they chose and any gestures or emotions they displayed during the interview process. I took careful notes to capture as much details as possible about the context and setting chosen by my participant. I concluded the second session by engaging my participant in member checking and asking them for a time and date for the 3rd session. Once the time and date were determined, I asked them to bring 3-5 artifacts that reminded them of pivotal instances of a lived curriculum, in other words, anything significant outside of school or work, such as their family, church, or any other types of supports that helped them navigate through their STEM journey. I also asked them any specific questions that came up from my analysis of the two prior interviews.

For the 3rd interview, I asked my participant to show me the objects they chose that reminded them of pivotal instances of a lived curriculum. I recorded the interview and listened carefully so that I could transcribe the interview as accurately and as vividly as possible. Again, I noted the setting that they chose and any gestures or emotions displayed. I concluded the third session by engaging my participant in member checking and requested a final follow-up interview session which was conducted at a time and date of their choice. After I completed the interview sessions with my first participant, I transcribed the recorded interview verbatim.

To further enhance the account of my participant's life history, I also created a STEM journey path-line that served as a visual chronological organizer using photographs of their pivotal instances. I used shapes to signify categories, such as using a triangle for the student, a rectangle for the teacher or professional, and a trapezoid for the lived curriculum. I indicated the importance of each pivotal instance by increasing the font for something that was very important for my participant or decreasing the font for something that was not as important in their perception of their journey. I also color-coded the shapes, green for positive pivotal instances and red for negative pivotal instances. This legend helped me to identify important themes or categories and deepened my analysis of my participant's STEM journey.

During the final interview session, I shared my transcription with my participant, as well as their STEM journey path-line to ensure the fidelity of their life story and to make sure that I was representing their life history as accurately as possible. My participant was able to give me feedback and make any revisions that they felt is necessary to represent their holistic life history account.

Interview prompts

For the 1st interview, I asked my participant to show me the objects that they chose for our first session. I asked them what these objects represented for them and used them as talking points to guide our discussion. I asked my participant why they chose the particular artifacts that signify pivotal instances in their STEM journey as a student. I asked the significance of each artifact and asked them to tell me a story about each artifact, so that I could understand the context of each artifact chosen. I recorded the interview and listened carefully so that I could become familiar with my participant.

For the 2nd interview, I asked my participant to show me the objects they chose for to signify their pivotal instances in their STEM journey as an educator, and those objects were the

talking points for our second session. I asked my participant why they chose the particular artifacts that signified pivotal instances in their STEM journey as an educator. I asked the participant the significance of each artifact and asked them to tell me a story about each artifact, so that I could understand the context of each artifact chosen. I recorded the interview and listened carefully so that I could transcribe the interview as accurately and as vividly as possible.

For the 3rd interview, I asked my participant to show me the objects they chose that reminded them of pivotal instances of a lived curriculum. I asked my participant the significance of each artifact and asked them to tell me a story about each artifact, so that I could understand the context of the artifact chosen. I recorded the interview, and listened carefully so that I could transcribe the interview as accurately and as vividly as possible.

Researcher journal

I used my reflective journal as a data source. I wrote extensive, descriptive notes as I went through the interview process and reflected on the experiences gained through the research project. Journal writing began as part of the data gathering process.

Data Analysis

Data as text

Cole and Knowles (2001) note that "understandings of participants' lives in context can never be truly whole or complete; however, we must strive to honor the richness and complexity of lives lived. We gather information from participants in bits and pieces and store them in a safe place to make sense of them when we are ready to analyze them. However, to make meaning of these data, "we try to understand, in a holistic way, the connectedness and interrelatedness of human experience within complex social systems" (p. 101). Ojermark (2007) states that the emphasis here is "on the active construction of life stories through the interplay between interviewer and interviewee." Cole and Knowles (2001) put it in a simplified manner, it is "like

getting to know a very good friend, because we have spent so much time together and come to know so much about her, eventually we begin to think, just a little, like her" (p.101). The finished document will be the result of a collaborative project. The informant's point of view will be treated as "a unique perspective mediated by social context" (p.5). Ojermark (2007) notes that "analysis is of the interview itself, or the informant's view of reality, the themes that emerge from the narrative, how they reconstruct the past and meaning" (p. 5).

Analysis

Cole and Knowles (2001) state that "the descriptive level of analysis and representation provides the foundation and organizing framework for the subsequent levels of analysis and the ways in which meanings are derived and represented" (p.117). The use of life history methodology in non-linear and recursive. Cole and Knowles (2001) emphasize that in contrast to research representation that is linear where data and analysis is "written up", life history seeks to "write for meaning rather than to record meaning" (p.122). Lives are complex and messy, therefore a researcher becomes "a writer of lives must extract individuals from their chaos yet create an illusion that they are in the midst of life- in the way that a painter arrives at an approximation of a familiar visage on a canvas" (p. 122).

Jupp (2013) provides an example of data analysis as it relates to life history research. He states that this recursive and non-linear analysis involves "1) identifying emergent patterns in interview transcripts, 2) contextualizing patterns within existing research and other documents, and 3) working reflexively through my positionality as teacher of inner-city students" (p. 151). Therefore to analyze the data collected, I used: 1) in-vivo coding and categorization of data to look for emergent patterns, 2) critical literatures for context and identifying patterns, and 3) my underlying researcher positionality as a STEM student and then a STEM discipline educator.

Using these three components helped me identify, explore, and analyze themes or patterns of my participants' lived experiences and viewed through historical and social contexts.

Ethical Considerations

In order to follow ethical considerations, I provided informed consent to each of my participants. I made sure that the participants' data and identity were kept confidential. I also made sure that my participants had a chance to review and validate the data once I finished transcribing it. I tried very hard to report the participants' experiences to the best of my abilities and shared any common findings between and among their experiences.

Informed Consent

Before the interview process began, my participants were provided with an explanation of the purpose of my research, the expected duration of their participation, and a description of the procedures to be implemented. I also informed them of any foreseeable risks or discomforts as well as a description of any benefits as a result of participating in my study. If any of my participants felt uncomfortable when sharing any unpleasant experiences, they were able to take a break or stop whenever they needed to.

Confidentiality

As a researcher, I made sure that the data that I collected was safely stored and could only be accessed by me. Data was stored in a computer that was password protected and was backed up to an external drive that I kept under lock and key at my house. I also used pseudonyms (of my participants' choice) for each one of my participants to maintain confidentiality. I used general descriptions for the schools they attended, the places where they worked, and the careers they have chosen. The privacy of each of my participants was important to me, and I made every effort to protect it before and during the recruitment process,

the consent process, and throughout their participation in my research study. I conducted my research study in a private setting and made sure that data was not collected without each individual's knowledge and consent.

Member-checking

In order maintain ethical considerations, the interviews that I transcribed, any themes that emerged, and a report of the results were given to the participants to review and verify. This routine allowed me to proceed with my analysis of the data collected and an interpretation of the findings.

Reliability and Trustworthiness

Measor and Sikes in Kouritzin (2000) note that the "relationship between researcher and researched becomes one of friendship, togetherness, trust, and pursuit of a common goal, a relationship that progresses over the course of the project" (p. 6). Knowledge transfer from researcher to reader needs to be done through "conceptual structures, advanced organizers, schemata, scaffolding and unfolding of realization" (p.95). Lincoln and Denzin (1998) note that in the process of sharing ideas, researchers pass along some of their personal meanings of events and relationships. The reader will also reconstruct what they read. The authors advise that "to reduce the likelihood of misinterpretation, we employ various procedures, including redundancy of data gathering and procedural challenges to explanations" (p.95). To address the issue of trustworthiness, I used participant data to provide comparative evidence of the lived experiences of these Latinas as they attained their degrees in the STEM fields. Lincoln and Guba (1985) state that researchers can use various techniques to ensure trustworthiness: credibility, transferability, dependability, and confirmability.

Credibility

To establish credibility, or confidence in the "truth" of findings, I used triangulation. Using life history also entails triangulation. This triangulation is done so that the researcher understands what has been omitted or what subjective meaning has been given to narrated events. The events themselves are of some importance, but of even greater importance is how the participants understand the events and how they impact their lives. In other words, the truth that participants tell "can be quite different from the 'historical truth' of what happened in their lives, but nevertheless it has a force in their attitudes and actions" (Kouritzin, 2000, p.4). I used member checks, which occur when "data, analytic categories, interpretations and conclusions are tested with members of those groups from whom the data were originally obtained" (Lincoln and Guba, 1985).

Transferability

To ensure transferability, I used thick description, which is a "detailed account of field experiences in which the researcher makes explicit the patterns of cultural and social relationships and puts them in context" (Holloway, 1997, p. 1). Through the use of thick description for each one of my participants, I used these important details to make sure that any conclusions I come to can be transferred to other times, settings, situation and people, especially among my participants and the participants in the studies that I have read as part of my literature review.

Summary of the Chapter

This chapter, began with a presentation about my positionality as a researcher. It then provided a brief history of the research design methodology. It described of the research design, life history methodology, and the rationale for using life history. The methodology section provided a detailed account of the criteria used to select the number participants and described the setting. Next, I described the process of how I gathered life stories of my participants through three interview sessions. I also detailed the interview prompts that were used to begin each interview, and I discussed my research journal and the data analysis techniques. And finally, I discussed the ways in which I accounted for ethical considerations which included informed consent, confidentiality, as well as issues of reliability and trustworthiness. Chapter 4 provides the data and its analysis.

CHAPTER IV

FINDINGS

This qualitative life history study explored the lived experiences of four first-generation Latinas who successfully navigated the Science, Technology, Engineering and Math pipeline to obtain a bachelor's degree in one of these fields. This chapter discusses data from three interviews with these Latinas. First, the profiles of each Latina is depicted. In the first interview each Latina discussed her STEM journey as a student. The second interview focused on each Latina's STEM journey as an educator. And the third interview related each Latina's STEM journey through the lived curriculum. The charts below show the themes that emerged from each of the three interviews and identify the primary findings that pertain to these themes.

Table 1: Themes

Interview 1: STEM journey as a student	La Familia y La Cultura Latina STEM identity Sense of Belonging The only female
Interview 2: STEM journey as an educator	Difficult transition Self-sufficiency Back to STEM
Interview 3: STEM journey as a Lived Curriculum	Latinas as STEM role models Latinas Pay it Forward

In the first interview, the participants discussed their STEM journey through a student's perspective. The themes that emerged were the Latina's early interest in STEM, Latina's challenges and opportunities, Latina's STEM degree attainment. In the second interview, the

participants discussed their STEM journey through an educator's perspective. The themes that emerged were STEM degree holder to STEM discipline educator, Lessons Learned and Paying it Forward. In the last interview, the participants discussed their STEM journey through the lived curriculum and themes that emerged were lived experiences that reinforced their STEM identity and lived experiences that gave them a new perspective as STEM Latina role models. This chapter also discussed the findings derived from these themes and their connection to the literature as listed below.

Table 2: Primary Findings

Interview 1: STEM journey as a student	A common finding among all participants was that Latinas were helped by their parents to develop their STEM identity and were expected to go to college. An interesting finding that emerged was that these Latinas were motivated by challenge and that challenge was multi-faceted.
Interview 2: STEM journey as an educator	An important finding that emerged is that these Latinas' STEM degree gave them a position of privilege, but it also served as a way that marginalized them.
Interview 3: STEM journey as a Lived Curriculum	A distinct finding that emerged is that teaching a discipline in STEM education was a complicated choice, but it was not always a first choice for all of the Latinas that participated in this study.

As discussed in Chapter 3, I analyzed the data from each participant through the three interviews and then across the participants. In this chapter, I discussed the themes that emerged throughout my study. I coded the themes thematically and noted how the themes emerged as I followed each Latina's journey from STEM student to STEM educator. Each section shows the themes that emerged to gain insight into my research questions.

In this study, there were four participants, myself included, who were eager to share their

lived experiences as they journey through the STEM pipeline. However, when the first interview began, the participants were a bit nervous. Each one of them stated that they hoped that they were answering the questions correctly. There was one participant who had much to say about her lived experiences, especially in the education field, but shared very little about her family life. There were moments where I would get excited as a researcher, because I found my same lived experiences validated through someone else's life story. At this point, I began to see the personal connections that we all shared, even though I had not known my participants before my study. This study made each one of us reflect on our lived experiences and think about how far we have come as educators, when a long time ago we were dreaming about obtaining a career in a STEM field. For most of us, it is bittersweet: developing our STEM identity, the preparing for STEM without knowing, the challenges and opportunities presented along our STEM journeys, and the sense of belonging in the education field, even though that was not our first choice. The following section elaborates on each interview and the themes that emerged along with supporting data.

For the each of the three interviews, I asked each participant to bring 3 to 5 artifacts that signified their STEM journey as a student, as an educator, and through the lived curriculum. But first, I wanted to build a rapport with each of my participants and wanted to get to know them better. I began the interview by asking them about their background and about their family and by sharing my background and family as I was growing up. Since, we were still in the latter part of the Covid-19 phase, I met with each participant through Zoom. The participants seemed to be at ease when they were sharing their STEM journey through each perspective.

After the interviews were conducted and transcribed, I often found myself thinking about how I did not know these women when I asked them to be a part of my study, but as I listened to their life history accounts, I felt like I had known them for a long time. They seemed to have a life

similar to mine. Every time I interviewed my participants, I was excited to learn a little bit more about them and their STEM journey. I felt as though I was reading a different book every time I met with each one of my participants.

The following section discusses the profiles and the themes that emerged from each interview.

Life History Profiles

The participants' profiles are the first representation of the participants' life history. The life history profiles presented an overview of participants' life histories. These life history profiles "provide for emergent patterns of participants' lived experiences" (Jupp, 2006, p. 117). These patterns were discussed as emerging themes in this section.

Christina

After a couple of months of building rapport with Christina in person, through e-mails and phone calls, I met with Christina for our first interview session. Christina was a bit nervous and stated that she did not know if she would answer the questions well, but would try to do her best.

Christina identified herself as a Mexican-American, first-generation high school and college graduate. She is the eldest of two children, and the eldest female child of two Mexican American parents. She has a younger brother. They've lived here in Bordertown for their entire upbringing. Christina's family lived in a middle-class neighborhood during her childhood. Upon completion of high school, Christina had plans to attend an undergraduate university, UTAH University, but her parents convinced her to stay home. She earned a bachelor's degree in Chemistry. Therefore, she also identifies as a STEM degree holder.

Christina's family lived in a middle-class neighborhood. Her dad worked as an auto parts

salesperson and her mom worked with city management. Her parents worked for most of their lives to provide a good home for their two children. Christina said that they would eat together at dinner and that they always had that constant communication. Christina stated that [school] "was always pushed at home, always, always". They recently retired and plan to embark on a new chapter in their life. They felt fulfilled that both of their children graduated from college and were both educators at the time of the interview session.

Christina: inquisitive love of science. There were many educational opportunities accessible to Christina throughout her STEM educational journey as a student. Her parents laid down the foundation for Christina's education at home. They also made the sacrifice early on to send Christina to a Montessori school. Christina's first artifact that was representative of her STEM journey as a student was a picture of an encyclopedia set. Christina's parents bought the encyclopedia set for her and referred to it constantly in the interview. Christina said that she was a very curious child and whenever she had questions, her mother would tell her to look things up in the encyclopedia.

> So, at home, my parents ordered an encyclopedia set. I loved my encyclopedia set. It was a point of pride. Just for fun, like on my own, I would go through them. I remember just spending my afternoon looking through those books. I found it so fascinating how you could, I mean, like how things were explained. (Christina, Interview Session 1, October 2021)

Christina reflected on this artifact and thought that since she was a really young child, she wanted to know how things worked. She liked to see how things worked behind the scenes to get a more complete understanding. She noted that "Like I was very curious as a child."

Christina talks about an expected norm for girls without realizing it. "I wouldn't take things

apart. I wouldn't do that because I feel like I was more well-behaved." Unbeknownst to Christina, it is "through doing (rather than memorizing) STEM, students can come to understand it as a creative process of inquiry. They can develop positive STEM learning identities that can guide them in future academic and career choices" (Bevan, Ryoo, and Shea, 2017, p. 1).

For some reason, Christina noted that she had the best memories of being a student when she was in elementary. The second artifact that Christina chose was important to her in her STEM journey as a student. She chose a frog dissection that was very significant to her but not very common to other elementary students.

> So, in fifth grade, like I told you, I was always stuck to my elementary, my younger years. Apparently, I was in the GT class. I did not know that was like . . . that they had a separate number of students for GT class, right. We did the lab for dissecting a frog. I was so excited about it like, I just could not wait. (Christina, Interview Session 1, October 2021)

Christina noted an expected norm comment from the girls in her class.

> 'Christina, how are you doing that? And oh, it's so gross and it smells'. I was just excited, and I remember looking at all, you know, the organs and everything and just be amazed at how like, you know, everything works and I just thought it was very cool and I also remember like, you know, other kids saying 'oh, she's a girl, you're not supposed to be able to like that'. However, I took the lead in that project and I was able to you know, I learned a lot and I really liked it. (Christina, Interview Session 1, October 2021)

Christina states that middle school was a blur, but that she did love her science classes which led her to enroll in a magnet program in high school.

> Up until high school, I decided to go to Higher School for the medical magnet program. So that's where I thought I wanted to go to and I was in the medical classes. So, I did several dissections there: we did a frog, we did a cat, I think we did a…Oh my God yes, we did a heart and several organs. I was always the first one like ready for it. And yes, I went through the whole medical pathway and I participated in like HOSA. I did biomedical debate. (Christina, Interview Session 1, October 2021)

Christina thought about her high school experience and although she liked taking the medical pathway, she reminisced that sadly " it turned out, like, it wasn't really for me. I'm like maybe the medical aspect wasn't for me, but I just always had that love of science, right?" Christina knew that science is such a broad field and felt that when she graduated "well I know I wanted to do something in science."

Christina graduated from Higher High School and knew that she wanted to pursue a STEM degree in a science area. Christina knew that the expectation from her parents was to attend college after she graduated from high school. She chose a third artifact to represent her STEM journey as a student and it was a logo from Stanford University.

> I want to show you. I mean it's just a logo, but my cousin actually graduated from Stanford University in 1994. You know just that idea that you know, somebody from here, our little Bordertown, you know, one of our family members, was able to go to this amazing university, graduated as an engineer. (Christina, Interview Session 1, October 2021)

Christina enrolled in STEM classes at Bordertown University. Although she had begun with an interest in biology as a major, she changed to chemistry as her major because a female professor noticed her affinity with chemistry. When asked if there were a lot of women or girls or Latinas interested in chemistry in her college classes, Christina described that there were no more than 8 or 10 girls that graduated in chemistry. She went on to say, "And I think I was one of three girls that actually graduated the exact same year as I did. It was very rigorous. It was very difficult."

Christina was able to successfully graduate from Bordertown University with a degree in chemistry. However, she faced career challenges obtaining a job in her field once she graduated. Since, Christina did not apply for jobs prior to graduating with her undergraduate degree, she was not sure that she could apply her bachelor's degree at the job they offered her. Therefore, she embarked on a different career as an educator.

Christina noted that a 5th grade teacher made a great impression on her because she provided her with her first hands-on experience through a science lesson of dissecting a frog. Her teacher provided her students with many hands-on activities which enhanced her love of science. In, high school, Christina also remembers her high school teachers who nurtured her creativity and love of science with hands-on activities, projects and extracurricular activities as she progressed along the medical field pathway. These teachers made a lasting impression on Christina that when she obtained her STEM degree, she would be able to transition into the education filed.

Christina's STEM Journey as an Educator. Sometimes life prepares you early on for your true calling. Although Christina did graduate from Bordertown University with a bachelor's degree in chemistry. She faced career challenges obtaining a job in the STEM field she had chosen:

So uhm, I ended up well, here I am with a chemistry degree, right. And I'm like,

> okay, well I'm here in Bordertown, you know what am I going to do? So, I actually applied at PUB to come to, you know, to test the water samples, right? So that was like the hardest interview I had ever been on. It was a panel of like 12 men. Of course, right? Like all men and a little me who just graduated from college and you know, they're asking me all these questions and you know how would I do this and how would I conduct that? And I was very nervous, but excited. You know, just you know, for something different or something I can actually do with my degree. (Christina, Interview Session 1, October 2021)

Although, Christina hoped that she would be able to use her STEM degree in her new job, she was unsure of her ability to do so. She recalls another option that would place her on a completely different path than what she'd hope for:

> So, then I applied as… I wouldn't have my certification, so I applied as a paraprofessional. And I believe it was like within like a week later that I went to that other interview or something that they had posted for a para-professional. They called me and I'd actually… I was in the parking lot and they, like, offered me the position. So, I was like oh OK, like alright. Maybe a couple days later they called me from PUB, offered me the position, but I had… I was already committed over here, so I said. No, I'm… I already made a commitment, you know. So, I'm gonna stay here. (Christina, Interview Session 1, October 2021)

Christina did not know the value that her bachelor's degree in chemistry afforded her. She wanted a job and without any prior working experience or knowledge of pay grades, she decided to go with the first job she was offered. It is important to note that due to her Latina culture, she had to stick to the commitment she had made to the school district rather than do what was in her best

financial interest.

Christina worked at the Public Library while pursuing her STEM degree, but since she was good at doing story time and arts and crafts, people assumed she would be a teacher. This career field is very common among women. However, Christina seemed a little bothered that people thought she was aspiring to be a teacher, when in reality she was aspiring for a STEM degree in a male-dominated field, chemistry.

Christina began her career in education as a paraprofessional, but realized that she wanted something more challenging - to become a teacher. In order to be able to teach, Christina had to go through the Alternative Certification program. Even though, Christina did not have an education background, she was able to take some courses and pass a certification test to become an educator.

Christina began as a 2nd grade teacher, but found that she could relate better to her 5th grade students. She recalls that she had a great role model in 5th grade, and she decided to also inspire her students to love science.

> I like the sciences, like everything natural and the math. I would try and there was something I did forget like…OK, I knew how to solve it my way or how I learned it doesn't exist anymore. How we still teach it now, I mean, is this the best way for that? That was the only struggle that I had. But as far as the curriculum that's fine, it's good. I like tell my students like whenever you can come in here, like I'm going to get you to review everything you know. Like whatever you learn, like I expect you to learn everything that I teach you. But I'm gonna start with the basics. I mean like, I'm gonna give you the knowledge to build up on those skills. (Christina, Interview Session 2, November 2021)

As Christina became comfortable teaching, she looked for another way to help her students love science. Therefore, she signed up for an afterschool program where she could further inspire her students to engage in STEM activities. She wanted to hopefully motivate them to take STEM coursework in middle school, laying the foundation for high school magnet programs or career pathways.

> A couple years ago I also did a . . . I had an afterschool STEM class. Yes, it was really cool and we worked with Lego robots so they would code the robots, and I really enjoyed that so I did that I think like two or three years after school. (Christina, Interview Session 2, November 2021)

This activity is very important, especially for Latina students because they usually have a notion that programming or coding comes easier for boys. Through this afterschool program, Latinas get to code through trial and error which helps to boost their confidence in these STEM activities. I then asked Christina, what from your chemistry degree do you like or do they (the students) ever ask you like, oh like what did you or what did you graduate with? Christina answered

> Oh yes, they do ask me. I mean it's a really big jump from like basic, basic science to chemistry, but I do drop little hints like light for photosynthesis or maybe I show them like the chemistry symbol for water I tell them let's write like H2O like carbon dioxide CO2. (Christina, Interview Session 2, November 2021)

Christina is being a positive role model and showing students what she learned going through high school and college and showing them a little preview of what they will learn if they decide to enroll in chemistry courses.

Jacqueline

Jacqueline was my son's engineering teacher in high school. I had met her during several competitions my son attended while on her teams, but I had not really gotten well acquainted with her. Therefore, it took about 3 months to build a rapport with Jacqueline so that I could gain her trust, and she would be more comfortable sharing her STEM journey with me.

Jacqueline identified herself as a Mexican immigrant, first-generation high school and college graduate. She is the eldest, along with her twin sister, of four children. She was the oldest female child of two Mexican parents. Jacqueline's parents still live in Matamoros. She has two younger brothers. They lived in Matamoros, Mexico and had most of her K-12 schooling in Mexico. She came to Bordertown after graduating with her bachelor's degree. She lives here with her husband and two sons. Since she graduated with a bachelor's degree in engineering, she also identifies as a STEM degree holder.

Jacqueline's family lived in a middle-class neighborhood in Matamoros. Her dad had an auto shop where he would rebuild auto parts and sell them. Dad had an elementary education up until 5th grade. Her mom attended a school that trained her to teach elementary students, equivalent to an associate's degree in Mexico, which permitted her to teach. Her dad worked for most of his life to provide a good home for the children. Jacqueline's mom worked for a couple of years, but then her dad wanted her to stay home with their kids. They were able to enroll their children in a private Catholic school, which led to many educational benefits for three of the siblings later on in their lives.

Jacqueline: figuring it out on her own. Jacqueline faced several challenges during her STEM educational journey as a student. The challenges she faced were acquiring English language, deciding on a career pathway, lack of knowledge as she was considering going to

college, and being one of a few females in her bachelor's degree program. She also thinks that her challenges were opportunities for growth and self-discipline.

Jacqueline was born in November 1981. At the age of 7 years old, Jacqueline was enrolled as a student in a Catholic private school. She was fortunate enough to have learned basic English, which was a privilege for students in private school. However, since she did not like her first school, because they focused mainly on the religious aspect of schooling, she was able to convince her parents to move her to a different school. She felt that she was not being challenged enough. Even though she was young, she noticed that her first Catholic School did not really push any STEM curriculum. It was in the second Catholic school where she obtained a more rigorous curriculum and flourished in math and science. This new school was the first time that she began thinking about following a pathway in the STEM fields.

Jaqueline noted that attending a private school in Matamoros was a sort of tracking mechanism in itself. Only students whose parents would be able to afford to pay registration fees would be able to attend these schools. Therefore, she had access to a more rigorous curriculum and the ability to learn English, which would prove to be beneficial in her future career. The other students would go to school half a day in the morning or in the afternoon to a public school.

Because Jacqueline was a first-generation college student, her parents did not have the experience to advise her when it came to higher education opportunities. Jacqueline only had knowledge about preparing for college from what she learned at school through her coursework, teachers, or peers. An important note that Jacqueline emphasized was that there were really no counselors in high school that were available for guidance. If she was interested in going to college, she had to go in person and talk to somebody for information.

Jacqueline noted that in Mexico, high school was only two years. The first year was the

basics and the second year was like the pathway. She remembered that there were 5 pathways: Something dealing with accounting or business, something dealing with medical field, another pathway was like social sciences, another pathway was for humanities and then the one she chose, engineering. She decided which pathway to follow through process of elimination in spite of not having access to any detailed information about each pathway. She knew that she was good with numbers and decided that social sciences and business were too easy for her and that she wanted something more challenging. Jacqueline commented

> I'm gonna embrace that part that I know because all over, a lot of women are smart, right? But I have that inclination for knowing to do those types of jobs and my dad had his auto-shop . . . So, I thought, well, I think that makes money. That's the first thing I thought that would make money. It's okay, you know what, I'm smart and I might be able to do something like that. And this is when I decided to become an engineer. (Jacqueline, Interview Session 1, October 2021)

Jaqueline followed her inner passion and became an engineer. She noted that an internship at two companies prior to her graduation actually affirmed that she had chosen the correct career. Her friend's dad was working in one of the two companies where she was doing her internship. She applied, got an interview and began working as an engineer when she was 22 years old. She stated that her problem-solving skills and her organization skills were key in learning how to be a woman engineer. It allowed her to prove to her male colleagues that she did belong in that profession, and she proved to be a valuable asset due to her ability to adapt and be open minded to learn new strategies which included technology.

Since, Jacqueline did not apply for jobs prior to graduating with her undergraduate degree, she was not sure that she could apply her engineering degree at the job they offered her. Therefore,

she embarked on a different career as an educator.

Throughout her K-12 schooling, Jacqueline did prioritize school. Her grades her high enough to enable her to continue into college. She remembers reading about career options through posters placed strategically at the front of the high school she was attending. She knew she enjoyed and was good at math and science. Having little direction, she leaned on her own knowledge and STEM identity to pursue a degree in engineering. However, it is important to highlight Jaqueline's perceptions in the educational system from a perspective of struggle, power, and challenge.

Jacqueline was aware of her parents' work to provide financial support for her family. Her dad worked long hours at the auto shop and her mom made sure that they had a clean home with food on the table. Unknowingly, Jaqueline's mom provided a positive learning environment at home through her short-lived experiences as an elementary teacher. Her parents' hard work and their traditional relationship became a motivator and support for Jaqueline's future goals.

Jaqueline was encouraged to do well in school when she lived in Mexico. She was sent to a private school where she received a rigorous curriculum in math and science. Her mother told her to follow her passion and choose a career that would make her happy. Jacqueline knew that she was always a problem solver and that she saw things differently than other students. Jaqueline's first artifact of her STEM educational journey as a student was a handwritten problem about fractions. She really liked math and remembered an elementary teacher who made her learn about fractions the hard way.

> You know, all those years in elementary and when we I was in fifth grade, I was introduced to Uhm, maybe you don't remember but OK it to me is like I never gonna forget this, what I went through with fractions. I was adding fractions with different denominators, right? So I was, you know, I was just paying attention to the teacher.

> She was explaining and back then we had the green board with a chalk, you know? So, it was like I didn't understand and then I was looking around and feeling like "How come other people get it and I can't?" So I started feeling frustrated because I was thinking I'm supposed to be smart. I'm supposed to be getting this right. I say, ma'am I don't understand. I mean I just can't get it and she explain it to me and she said okay, I'm gonna give you this paper. Bring me your notebook and I will do 2 examples and then I'm gonna give you 4 so you can practice. But she didn't explain it to me. But I said OK, but she did the steps, right, so she gave it back to me. After school, I went home and then sat right away and that was the first thing I did. I don't really remember how long, but it took me a while to figure it out. I figured it out. Oh, but you know what, the thing is that now I get it. Now to me fractions are the easiest thing ever! (Jacqueline, Interview Session 1, October 2021)

Jacqueline always knew that she was smart. However, she became frustrated when she encountered a problem with fractions, which she did not know how to solve. Her teacher had too many students to re-teach so she did a couple of problems and gave Jaqueline homework. Jacqueline was a natural problem solver and a very persistent one as well. Even though it took her a while, she got the algorithm correct and figured out how to solve fraction problems successfully.

Jaqueline loved to do mathematics problems. And she learned that her forte was problem solving. She learned back in elementary to solve problems backwards, which in engineering is called reverse engineering. Jacqueline has been able to solve most of the problems she has encountered as a student using this method.

Jacqueline's second artifact was a picture of some STEM posters. Jacqueline remembered

seeing these posters at the secondary school she was attending. She reflected on her prior knowledge and skills to determine what career pathway she would be pursuing.

> Maybe because of my dad, uh, had a shop that will you know review some parts of the cars that were dealing with electricity of the car, right, I decided to be an electrical engineer. So, I signed up and I was, you know, hooked. I was kind of proud that I know things that girls don't know. (Jaqueline, Interview Session 1, October 2021)

Jacqueline's third artifact were some measurements of car parts. Jaqueline noted that when she went with her dad to the auto shop, she learned about mechanical things and how to measure and make drawings of auto parts. She was very proud of the fact that most girls don't know anything about cars, which led to her decision to become an electrical engineer.

Jacqueline began doing an internship at two maquiladoras (a Mexican factory) when she was still in college. Her boss encouraged her to finish her education. She still had about six months left to finish school and prepare for her final exams. And when she finished, he might be able to get her a job as an engineer.

Jacqueline also remembered a physics teacher that she had in high school who encouraged her to pursue a degree in engineering. The teacher's son and Jacqueline were taking classes at that time and whatever advice he would give to his son, she would take as well.

Jacqueline's STEM Journey as an Educator. Jacqueline's career changed as a result of getting married. She met her husband in Matamoros, but he lived in Bordertown. She came to the United States as an immigrant and gained citizenship through her husband. When she came to Bordertown, Jacqueline embraced her love of mathematics and applied for a position with a finance company. She did not even consider looking at the engineering field for a job because

there were limited opportunities at that time and she did not feel confident about coming to a different country and entering the STEM workforce because of the language barrier. She was immediately hired and began working. At the finance company, she met a substitute teacher who talked to her about his job and encouraged her to apply. Jaqueline recalls:

> So, when I started working as a substitute teacher, I started looking at all the classes that the high schools have to offer. Obviously, I don't think I will be able to be an elementary teacher. Probably middle school or high school. So, when I saw that for me math was kind of easy, I want to be an Algebra teacher. So, I started you know, I went through the state and got my certification in Math and I started teaching right away. I started teaching at Link Park. I was teaching like 4 different classes: one called STARS, and I did Algebra I, Algebra II, and Pre-Calculus. I taught parents or pregnant students. They offered those classes there for the girls so they can finish high school in two years. (Jacqueline, Interview Session 2, November 2021)

Since, Jacqueline was new in Bordertown, she had not applied for any jobs where she could use her undergraduate degree. She did take advantage of her mathematics background and applied as a substitute teacher. After gaining some teaching experience, she went through an Alternative Certification Program and got her teaching certificate. She then embarked her new journey as an educator.

Jacqueline had a hard time adjusting to her first job in education because that was not the field she had intended to work in. She had graduated with a STEM degree in the field of engineering but had to accept a job in education because she did not feel that she could challenge the engineering exam to get her certification in the U.S. due to her lack of English language

proficiency.

Jacqueline felt lost in this new world of education. She was humbled when a fellow colleague lent her his syllabus. She did her research on how to use a syllabus, how to write lesson plans and how she was going to be evaluated as a teacher using the Professional Development Appraisal System.

In order to be able to teach the math classes correctly, Jacqueline began taking notes and doing research to teach herself best teaching practices. She went from being the new teacher, to teaching other teachers her new teaching strategies.

> But from one year to another, I got the hang of it. I wrote my notes for the month. I had to do this and this month I have to do that. So, I'm kind of organized and within three years, I was teaching other teachers 'oh this is the way I do it'. So, because I always think as an engineer, I always like to facilitate the work for me, right. I think I can do this better and then I find ways right, and me being good with technology, so I can do this or I can do that. With technology I saw a huge difference, especially with the calculators. We had, I remember, a TI-84 and now we have the same one but in color and I always been kind of teach myself to do things. So at Link Park, which is kind of a forgotten school, I will just watch YouTube videos about how to use a calculator. In three years, I was in all the committees. I was in the hiring committee, I was in the attendance committee. Not soon after, I became a department head. And in three years, yes, it was kind of, uhm, I think I learn kind of fast. Yes, but I did it. (Jacqueline, Interview Session 2, November 2021)

Jaqueline always knew that she was smart, and she did not like feeling lost, especially in a field

where she knew mathematics and how to be a good problem solver.

Jacqueline recalls the next educational opportunity that helped her move closer to applying her engineering knowledge to the education field. She was teaching physics when a curriculum specialist advised her to apply for Career and Technology as an engineering teacher. The specialist mentioned Jacqueline's name to the CTE director who called and interviewed Jacqueline. He encouraged her to transfer to Higher School magnet for STEM, which she did as her son was going to this same school. That year she began teaching engineering courses through Project Lead the Way.

Jacqueline was doing so well teaching upper level high school STEM courses that a curriculum specialist encouraged her to move to her area of expertise: engineering. Jacqueline noted that she had some difficulties transitioning over to the engineering classes, but mainly because the school district did not provide training to implement these classes successfully.

Once again Jaqueline reverted to doing research and familiarizing herself with vocabulary and skills of a different engineering field, aerospace engineering. She was proactive and used her problem-solving skills to get herself ahead of the game and teach her students in an informed way.

After this tough first year of teaching engineering courses on her own, the district finally sent her to the trainings that she needed to be certified in this teaching field. Jacqueline chose her first artifact that was important in her STEM journey as a teacher. It was her Project Lead The Way transcript of her core training.

> But once I went during the summer to do the training is a two-week training. I was surprised that when I went to Maryland for this training, some teachers were saying how did you learn to speak English well? But you know, I had a need and that was all I needed to push myself and learn. So then okay, I got it. Those are the classes

> that I am actually teaching. It is introduction to engineering design and then the following year in 2018 is the second one. For the last one, I had to make a sacrifice and pay out of pocket so that I could travel to Maryland to get certified. It was a really good experience. (Jacqueline, Interview Session 2, November 2021)

The second artifact that Jaqueline chose to signify her STEM journey as a teacher was a video of her students testing a rocket outside of her classroom. OMG that was a failure! I asked Jaqueline if they were testing those rockets for Space X. Jacqueline said no. The project is something that the kids do in the engineering classes. So, they didn't follow directions correctly and this is what happened. Instead of going up and of course because of the wind, they have to do this type of path. The third artifact that Jaqueline chose was a picture of her room with testing equipment.

> I have in my room some testing equipment. It tests how much force material can withstand. So, the students, they run the test and it's kind of interesting how they like it. Especially the boys, because you get to destroy things. You start putting a lot of pressure on the material until it breaks. Because that's actually testing how much force it can withstand. So, we are always working with projects, and it's a lot of work because you have to have all of the materials ready, the lessons, follow all the precautions so that students don't get hurt. And then getting everything cleaned by the students can be challenging at times. But it's fun. I love to teach engineering classes. (Jacqueline, Interview Session 2, November 2021)

Jacqueline so enjoyed teaching Project Lead the Way Classes, she also signed up as a sponsor for extracurricular activities such as FIRST (For Inspiration and Recognition of Science and Technology) Robotics Competition. FIRST is a global robotics community preparing young

people for the future and the world's leading youth-serving nonprofit advancing STEM education.

> Even though I especially had a hard time with the robot, the robotics part. Uh, I didn't, you know, I didn't grow up with robots at the time. Right, uh, and uh now I kind of like, you know, I don't blame the kids that they don't know how to do it but I, I think I have to provide them with scenarios. You have the lesson, the activity, everything, but in order for the students to do them, you have to explain it. And if you don't know what the activity is about, then well the kids are not going to be successful because they're not gonna understand what to do. And that's the thing, you can be a very smart teacher, you can know your material very well, but it takes a special person to be able to transfer that knowledge to the kids. That's where like the teaching part is critical for them. (Jacqueline, Interview Session 2, November 2021)

Jaqueline reflected on her STEM educational journey as an educator. She remembered that even though she had actually obtained her STEM degree in one of the hardest fields for women, engineering, she struggled to transfer her knowledge of the discipline into educating students about these fields. But once she mastered the art of teaching a discipline that she loves, she makes it exciting and fun for her students to learn these difficult concepts.

Regina

I met Regina through a colleague at work. Regina is her sister-in-law and suggested that I ask her if she would like to participate in my study, as she fulfilled all of the requirements for my study. My colleague is also working on her doctorate, but unfortunately did not obtain a degree in a STEM field. She was key in gaining Regina's trust and building rapport because Regina saw how hard the teacher was working on her own dissertation and was glad to participate. Regina has also noted that she is interested in participating because she might pursue a doctoral degree herself. Therefore, it took about a month to build a rapport with Regina.

Regina identified herself as a Mexican-American, first-generation high school and college graduate. She is the eldest of two children, she was the oldest female child of two Hispanic parents. Her mother is Mexican-American and her father is Puerto Rican. She has a younger sister. Regina has lived in Bordertown all of her life and had her K-12 schooling here. She left home to attend college at University Station but came back to Bordertown after graduating with her bachelor's degree. She lives here with her husband and two sons. Since she graduated with a bachelor's degree in biology, she also identifies as a STEM degree holder.

Regina's family lived in a rural area in Bordertown. Her dad was from Puerto Rico and her mom was a government employee. Regina has a sister who is younger than her. Regina's parents worked for most of their lives to provide a good home for their children. They were able to enroll their children in a private Catholic school, which led to many educational benefits later on in their lives.

Regina: veterinary school heartbreak, now what? Regina's father was a big hunter. Regina states that her father raised her and her sister as tomboys because he didn't have boys.

Regina's first artifact was a picture of her family hunting. She remembers that her father tried taking her hunting one day when she was 6 years old and unknowingly sparked her interest in STEM.

> So he tried to take me hunting one day, and it was dove hunting. So, as he's shooting the doves, I remember I was like 6 years old and I'm supposed to be getting him [the dove] and putting it in the bag, right? And instead of doing that, I was grabbing him. I was trying to make him better and I was sitting there crying and crying. So, at an early age, I always told my family that I was going to be a veterinarian. (Regina, Interview Session 1, October 2021)

Regina remembers her father and her uncle's ranch as paving the way for her science interest in animals and caring for them. She remembers wanting to be a veterinarian and buying her uncle's ranch to be a sanctuary for her patients.

Regina's educational STEM structures began with her experiences out of school. Her second artifact was a picture of her uncle's ranch, which she wanted to buy for her future veterinarian business.

> The second one is a picture of my uncle's ranch. So, my uncle had his ranch and I would always tell him 'Don't sell it cause when I get older, I could already envision it being an animal sanctuary', so when I got older and I was going into school, science was just always my interest. Reading all I could about animals. Learning about them, you know when an animal got sick, what medicine he could take and not take. And a lot of the animals on my uncle's farm or his ranch, you know they would treat them there at the ranch. I was learning about medicines and which antibiotics to give them and different things like that. So, I always had an interest

in that at a really early age. (Regina, Interview Session 1, October 2021)

Regina had big dreams about buying her uncle's ranch and making it a sanctuary for her animals. Regina did not know at the time that part of that dream would become a reality, but not the one that dealt with obtaining a STEM degree.

There were many educational opportunities accessible to Regina throughout her STEM educational journey as a student. Regina noted that: "With me, my parents never had to push me. I really like school. I always knew that that's what I wanted to do. So, for me, school came easy. I enjoyed it."

Regina recalled knowing that science was her interest, but one of her 5th grade teachers made a great impact on her schooling. Regina chose her third artifact, which was a picture of a skeleton.

> I always knew that science was where I wanted to go, but my first major was zoology. So that's what it was. Because I thought, you know, I could even be a vet at a zoo. But then I realized that that was so narrow because we don't have that many zoos, so I didn't know what my options were. So, luckily, like in elementary I had a great science teacher in 5th grade. And that was, you know, I still remember she had a skeleton. I went to Rosco Elementary and her name was Mrs. Rene and she had a skeleton hanging, you know and she would teach us the bones and all of that and that's something I learned early on. (Regina, Interview Session 1, October 2021)

Regina remembers this teacher as being a role model to the young would-be scientist. She was fascinated by several aspects of biology, which guided her through elementary and middle school. Regina did not mention much about middle school, but she remembered a lot about high school.

Regina faced several challenges during her educational experiences. The challenges she faced were deciding on a career path, managing finances as she was going through university, and being one of a few females in her bachelor's degree program. She also thinks that her challenges were also opportunities for growth and self-discipline.

Since Regina was in private school, she did not experience tracking as students in the public school do. She had the same classes and expectations as her peers because their parents paid for a quality education.

> I went to Saint Joe. My parents were middle income, so I know that they really, you know, sacrificed a lot to have us go there. And so, I was at school with kids whose parents were doctors and lawyers and business people. And my parents were just regular people with regular jobs, so I saw you know the beautiful homes that they lived and the vacations they would go on . . . Yeah, because you know you gravitate towards what's familiar, so that's what they so, so they just fell in line with what their parents did and my parents weren't professionals, so it's like what am I interested in? And you know , I kind of just went with my own interests. (Regina, Interview Session 1, October 2021)

Regina paid attention to what her peers did, and the counselors would just place them in the classes they needed to be in. At that time, there were no career pathways in private school.

Because Regina was a first-generation college student, her parents did not have the experience to advise her when it came to higher education opportunities. Regina only had knowledge about preparing for college from what she learned at school through her coursework, teachers, and peers. Regina recalled that although her parents went to college, they were unable to finish due to other responsibilities. Regina did know that going to college was an expectation

for her and her younger sister.

Regina always knew about her parents' expectations of her going to college. Although they did not push Regina into the STEM field, they did their best to support her education by having her in a private school where she would receive a more rigorous curriculum. Regina also credits her friends for helping her decide what college she would attend. "I stayed here one year, went to school here at, I think it was Bordertown College at the time. And then when I left to College Town University, I had friends there already that I graduated with and were already living there. I made my arrangements to be, you know, roommates I got . . . I did everything on my own.

Regina remembers that her counselor in high school was not very helpful in getting Regina into the correct school that fit her STEM interest. Regina noted:

> From where I saw, it's like the counselors at that time, they did not guide you. There was no, there was nothing. You know the way it is now where they have those career paths where they sit and work with you, I ended up doing with my counselor at the time. I can say that I didn't get anything out of that. I was self-sufficient I figured it out on my own. What college I wanted to go to, College Town University, I did my own research. My parents didn't help me with the application. I found my own scholarships. I knew what I wanted to do and I knew that if I wanted a better lifestyle, I needed to go to school and that was that. (Regina, Interview Session 1, October 2021)

Regina navigated getting into college mostly by herself. Regina did not talk about any college advocates.

Throughout her K-12 schooling, Regina did prioritize school. So, her grades her high enough to admit her into College Town University that offered math, science, and engineering

degrees. However, when she reached her undergraduate institution, she had not considered what major she was most interested in. She knew she enjoyed and was good at math and science. Having little direction, she pondered her science interests and decided to pursue a degree in biology. She was still hoping to become a veterinarian.

Regina had knowledge from books and brochures about scientists. However, she had not been exposed to veterinary or medical professionals. In high school she remembered:

> I learned early on, so I got an interest in that and I really wanted to go into . . . I was back and forth. At that point as I got older, between medical school and vet school. If I went the medical school route, I was going to go into radiology. But I was talked out of it. So . . . I was told it was a male-driven field. (Regina, Interview Session 1, October 2021)

Regina wanted to pursue a career in the medical field, preferably as a veterinarian, but was dissuaded to do so by her high school counselor. She was encouraged to go into the teaching field. She did not like that suggestion and signed up for biology courses.

Regina's STEM journey as an Educator. Regina's STEM interest revolved around life science, but specifically dealing with animals. Regina did take most of her coursework at College Town University, but graduated from Bordertown University during her last year with a degree in biology and a minor in chemistry. Regina was ready to apply the knowledge she gained through her coursework to her career but then began to question what her career would be when she realized that what she had planned for all her life did not feel right for her anymore.

> Then my mom, during that process moved to Galveston and I moved with her so, let me figure out what I am going to do. I was twenty. I've lost track of my age. Can't remember how old I was, but I ended up getting a job. I applied and got a

> job at the Microbiology Medical Cancer Research lab at UTMB, so I had already graduated. So, it's still part of the, you know, medical interest, right? Yes, I loved it. Yes, I got hired right away and I didn't think I would, but apparently, you know with my background and then I did the lab work for the vet at the time. So, I just got that job, which was a great opportunity, but I hated the city. And, so I was back and forth and that was like not, that's not what I wanted. It didn't interest me. So, during that time that I'm there, though, I get accepted into medical school and I realized it. It wasn't happiness when I got it. It's like, oh, like do I wanna do this? It was very questionable. So, in that time frame I didn't like Galveston. I knew I didn't want to go to medical school and thought to myself I need to figure out what I'm going to do. (Regina, Interview Session 2, November 2021)

Regina was finally accepted into medical school, however, Regina felt that getting that acceptance did not feel right. She decided to come back to Bordertown and try something different. Regina was excited to get a job in the education field, which was only supposed to be temporary. Regina remembers her first paycheck:

> And then I get my first paycheck and I wanted to cry. I wanted to cry because I was a paraprofessional. So I saw my paycheck, I was at Smart Elementary and it was a small school. We had a librarian, but we shared her with another campus, so I ran the library. So, then I get my first paycheck and I was a level 1 paraprofessional. It was like $400 and some dollars. And that's in spite of having a degree in biology. (Regina, Interview Session 2, November 2021)

So, Regina decided that she loved teaching and actually enjoyed it. So she learned about alternative certification, and went through that process. She applied at Morning Elementary and

began teaching 4th grade. Regina thought she was going to do that for a year. Her mom had moved back to Bordertown, so she moved in with her mom and she started working. Regina realizes "one year led to 31 years later," and she is still an educator.

Regina knew that she had found her new career and wanted to integrate her science background in some way to her new job.

> So, I taught 4th grade there with Mr. Harry and then fifth grade and then I had a science lab. He let me start a science lab at that time so I tell you what I did. OK, so that's where It started, that's how I ended up getting into teaching. I had a plan to go from A to B and it didn't work out that way. I was all over the place before I landed and what ended up being my career. (Regina, Interview Session 2, November 2021)

After a few years, Regina moved into her new position as a science and math mentor teacher, where she felt she could empower teachers to raise up to the challenge and teach quality science lessons to their students.

The Science Math Mentor teacher program ended after five years, and Regina became a dean of instruction for an at-risk middle school campus. Regina worked with middle school teachers and taught them about using data to drive their instruction. She told them that their tutorial lessons should focus on the skills where the students were weak. Teachers were not used to using data analysis to improve their teaching, especially in the areas of math and science, but with a little help, their scores improved and Regina's school was no longer at the bottom of the middle school list. Regina was just getting used to her new position as a dean of instruction, when she had to take a leave of absence to care for her new baby who was born prematurely and needed her time and care. She also had to refresh her biology knowledge to help her care for her infant who had

various health issues.

After going through this terrifying experience, Regina returned to teaching, but now at the university level as a lecturer for a year and then returned to teaching at Bordertown independent school district for the fall semester last school year as a 5th grade teacher. She is now a Math Specialist. Regina became an educator after she realized that her life-time dream no longer fit her aspirations. Regina accepted an entry level position at Bordertown as a paraprofessional, when she could have implemented the knowledge and skills that she learned when she obtained her bachelor's degree in biology and earned much more money. Regina realized that earning more money wouldn't make her happy. She now knew that being an educator was much more rewarding than she had ever imagined.

Cecilia

I embarked on this life history inquiry to make sense of my STEM journey throughout my life. I invoke Martinez (1996) to help explain this critical inquiry: "It is about my story, my personal history as Chicana, and as a feminist. In trying to know and understand my personal history, I take a step that sharpens my ability to envision the social world within the individual life, as well as the individual life within the social world, that is both theorizing and storytelling." (p. 109). I had never had time to reflect on all of the important moments in my life that have led to important decisions. They say that you need to do small things with great love, and that is what I have always done, without realizing it. In doing the small things, I discovered that I had a passion for Science, Technology and Math. During high school, I had pondered pursuing a career in Electrical Engineering, but was discouraged from doing so. Thus, I present the following as an account of my STEM journey.

I, the researcher, identified as a Mexican-American, first-generation high school and college graduate. I am the eldest of four children, and the oldest female child of two Mexican-American parents. I have three younger brothers. My mother came to the United States from Matehuala, San Luis Potosi, and my father was born here, in Bordertown. I have lived here all of my life, except when I left for college. I came back to Bordertown after graduating with my bachelor's degree. I live here with my husband, my daughter and my son. Since I graduated with a bachelor's degree in Computer Information Systems. I also identify as a STEM degree holder.

My family lived in a poor neighborhood in Bordertown. My dad, at my mom's insistence, bought a lot after saving several hundred dollars, then bought a trailer home, which eventually became our house. My dad only had an elementary education and was forced to work to help out

my grandmother, who was a single parent. My grandmother did not value education and so did not encourage my dad to go to school. He worked at different types of jobs. But had a steady one when he married my mother at the Bordertown Cotton Compress. He worked there for several years until it closed, was unemployed for a while, but found work as a deliverer of produce for a local company until about 5 years ago when he retired. My mom stayed at home until we were in elementary and then found work at a used clothing warehouse. Since she did not have an education past elementary, she had few choices for work. She retired about 15 years ago due to health reasons. We lived in my childhood home until we grew up and each of us left to pursue our own lives. My parents did not earn much, but they tried to provide for us as best as they could. When my dad lost his job, I remember having to go to the Texas Health and Human Services to apply for food stamps and several times going to our local church to get in line to receive groceries. At this point in my life, my mother and father instilled in us the value of education. They wanted for us to go to school and have an education, so that we could have a better life than they did. They had the expectation that we would all graduate from high school and when we got close, we would go to college. They did not have much money to have us in extracurricular activities or to take us to the movies, but one thing I do remember is that they made it a point to take us to the library, even if it was by bus.

Cecilia: family first, then what STEM career? My mother had a different approach to the life she was dealt with. She did not settle for the life that my grandparents wanted for her, to help them harvest the crops that they raised in Mexico and help them raise her younger siblings in Matehuala, San Luis Potosi. She came to the United States illegally in search of the American dream. She met my father and got married. She worked to help my family get ahead. My mother noted that I loved school and loved learning. She encouraged me, as well as my brothers, to try

our best at school so that we could get a good job when we graduated. She always made it a point to tell me that I needed to get a very good education, in case that if I ever got married and had children and, for whatever reason, was left on my own, I would be self-sufficient and not depend on anyone else to survive. I recall Martinez (1996) using a poem which depicted "women of color often tangle with the reality of differential experience:

I wonder why there are women born with silver spoons in their mouths
Women who have never known a day of hunger
Women who have never changed their own bed linen
And I wonder why there are women who must work
Women who must clean other women's houses
Women who must sell shrimps for pennies a day
Women who must sew other women's clothes
Who must cook
Who must die in childbirth
In dreams (Lim 1990: 26)

I bring this poem into my narrative because my mother cleaned other women's houses, worked at a cold storage facility deveining shrimp and packing it in boxes, and sewing clothes for other women. She did not want me experiencing what she had experienced as a Latina without an education. She wanted me to have my own dreams and be able to accomplish them.

My father shared some of the same feelings my mom felt. He wanted for us to do good in school and for us to graduate. He would help me with my homework and would give me spelling tests until I went to middle school. From that point on, he told me that if I needed extra help, to stay after school for tutorials. I did exactly what he told me, especially in high school, where my classes were Pre-Advanced Placement classes and I needed more help. Although, his mom did not value education, he did and he wanted the best for my brothers and myself. But I always thought that he took extra special care for me because I was his only daughter.

As I embarked on my STEM journey as a student, I faced several challenges during my educational experiences. The challenges I faced were acquiring English language, deciding on a career path, finding money to go to college, and being one of a few females in my bachelor's degree program. I also think that these challenges were also opportunities for growth and self-discipline.

At a very early age, I struggled with the English language because my parents spoke mostly Spanish at home. Therefore, when I went began elementary, I struggled to say things in English. My teacher would try her best to teach me things in English while explaining it at the same time in Spanish. This problem led me to become shy and not want to speak as much with my peers because I felt that I did not speak as fluently as they did. This shyness and self-consciousness about my language stayed with me throughout elementary.

Because I was a first-generation college student, my parents did not have the experience to advise me when it came to higher education opportunities. Luckily my teachers saw that I was a good student, they helped me enroll in advanced courses in middle school. Since, I was focused on having high grades in middle school, the counselors encouraged me to apply for honors courses at the high school level. I did take honors courses in high school, but did so because of my cohort from middle school.

As a result of my parents' decision to go to the newer school, I was also placed in an advanced track with the smart kids. I remember taking science classes with my professor who sat in my admissions committee for my doctoral degree. I also took Pre-Algebra in 8th grade with Mrs. T., who I met later on as a substitute teacher when she retired. I also took advanced reading with Mrs. Who moved onto high school at the same time I went. Being with such smart kids and having the expectation to excel from these high-quality teachers, made me strive for high grades

even in these advanced classes. I did very well that at the end of my 8th grade year, I was inducted into the National Junior Honor Society. In high school, I followed my cohort of students, and my counselor recommended that I take honors classes. I am so glad that I took these rigorous classes because they led me to opportunities that I would not have had otherwise. I was taking honors classes with students whose parents had a higher education or degree than my parents. I remember them being so proud of me when again I was inducted into the National Honor Society and I graduated number 7 in the top 5% of my class. This honor definitely meant that I would be able to go to college.

In high school, my female role models taught me about higher level math, but I also had the privilege of meeting my two science role models who would inspire and encourage me to attend college and graduate school. These STEM teachers nominated me for a TEX Prep Summer Academy at the Bordertown University. They noticed my interest in math and science and my high-grade point average and they thought that I would be an excellent candidate for this program. They encouraged me to apply and gave me good letters of recommendation.

I was so excited to be invited to attend the TEX Prep Summer Academy and explained the program to my parents. Although they were hesitant to let me go to the Bordertown University by myself for a long period of time, they did let me go because that was their dream for me, to go to the University. My dad would take me in the morning, and my mom would pick me up in the afternoon. That program opened up my eyes to the world of STEM. We learned about Boolean Algebra, a little about programming, some electrical engineering concepts as well as building projects as teams. I was determined to become an electrical engineer.

In high school, I met my female role models Mrs. Garcia and Mrs. Montanaro who taught Algebra II and Geometry. I thought it was so cool that they were females and knew about higher

level mathematics. I liked staying for tutorials, not only when I needed help but also to become as smart as they were. I also met Mr. Ramirez who was my biology teacher and Mr. Garcia who was my physics teacher. These two gentlemen taught me to love science, even though it was difficult. It was Mr. Garcia's 1st year teaching physics, and he had an all-girls class with 17 students. My peers and I were blessed to be in his class, and he was so excited that girls wanted to learn about physics. These two teachers organized a school field trip to a Biosphere named Rancho Del Cielo. This trip was literally heaven for me, and it enhanced my love of nature. This experience taught me how to observe the wonders of nature that are all around us, how to draw and write notes about my observations in my science journal. At the end of the day, my peers and I would get together and share our observations with our group. We bonded even more during that trip and still remember it to this day.

In middle school, I met my three closest friends and their parents. Since we were all taking the same challenging coursework and I was interacting with them in my classes, I learned that my peers had different ways of thinking. These interactions helped me gain information that would help me better prepare for college because my parents did not know how to do this. Throughout my high school years, I got to know my peers and their parents better because they often invited me to their homes to work on different projects. I would stay for dinner and would hear their parents talking about things we had to do so that we would be ready to go to college. Since some of them had gone to college themselves, I learned that we needed to take tests like the SAT and prepare a student financial aid application. Since my parents had no knowledge of how to do any of these things, they told me which documents I needed and how to apply to UTAH University, so that we would be set for college when we graduated. Luckily, I was blessed to have such good friends because they guided me during high school because their parents had gone through the

process. Although my parents didn't know much about preparing for college, they were supportive and appreciative of my peers and their parents' help with the process.

Another advocate for my educational journey was my high school counselor, Mr. Trevino. I had built a positive rapport with Mr. Trevino through his sons, my friend Santi and Junior who was my science teacher. Junior told his dad that I was getting good grades in his science class and in my Algebra II and Geometry classes and that my GPA was high enough to land me in the top 5% of my class. Mr. Trevino knew that I was a good student, but after my TEX Prep Summer Academy, I had questions about becoming an electrical engineer. He told me that although it would be hard it was possible to do it because I was a dedicated and smart student. So he found me several brochures about the school of engineering at UTAH university, as well as their school of computer science. He told me that I would have to apply to these specific schools, but that I should have no problem because of my grades, top 5% rank, the fact that I was a Hispanic female student interested in STEM fields.

Mr. Trevino was the first person who told me about UTAH University because he had been a student there himself. He talked to his contacts and gave me information about the STEM programs available at the university. According to him and various reports, UTAH University is ranked among the top universities in engineering and computer science in the United States. Once I was admitted to UTAH University, I made it a point to go to the financial office and figure out how I was going to pay my tuition at this prestigious university because my parents worked at jobs earning minimum wage. I made friends with a Hispanic lady that worked in the office, and she was very nice to me. She explained my financial aid package and told me that since I was a Hispanic female student with low socioeconomic status, I was getting much of my tuition and room and board paid for through grants. But I still had to get a loan to cover the rest. She told me

that I did not have to worry about paying the loan until I graduated and found a job.

Unfortunately, I did not graduate from UTAH University. I felt I was being marginalized in the STEM field I had chosen, computer science, where they identified me by my school identification number because there were so many of us in the classes, and I also felt homesick. I wound up going to Kingston University, which is smaller and closer to home. I also made it a point to go to the financial aid office at my new university and immediately related to the people there, because it was mostly run by students who made sure that you had everything you needed before you actually spoke to the financial aid officer. My college professors were also glad to help me. Since they had smaller classes, I was able to go with my Computer Information Systems teacher and ask him about debugging my programs. He was Hispanic, just like me, and wanted for me to succeed in his class. I wound up graduating from Kingston University with my bachelor's degree and high honors due to the professors who advocated for me because they got to know me as a person, rather than as a number.

Cecilia's STEM Journey as an Educator. Life takes many turns, and even though I did not graduate from the prestigious UTAH University, I did graduate from Kingston University, which was closer to home with a bachelor's degree in Computer Information Systems. However, when I came back home, I faced career challenges obtaining a job this field once I graduated. A particular struggle comes to my mind. I remember applying for several jobs from postings listed on the newspaper. I remember that I did not have a car and took the bus to my very first interview. I was walking to an accounting firm after riding the bus and was so nervous because I didn't even know what to say or what they were going to ask me. I went into the interview and there were a couple of men and a secretary in the office. They asked me several questions, but in the end, they told me that although my limited resume looked great and that my grades were really good, they

told me they were looking for someone with experience. I was told the same thing at the end of several other interviews, and I began wondering why I went through so much trouble to obtain such a difficult degree, if I couldn't even get a job offer.

Since, I did not apply for jobs prior to graduating with my undergraduate degree, I was not sure how I could apply my bachelor's degree at any job in Bordertown. I was so desperate to find a job that I ended up working with my mother for a couple of months, in a job paying minimum wage, even though I had a STEM degree. A friend of mine, who became a teacher, saw my struggles and frustration and suggested going through the Alternative Certification route. She told me to go to Bordertown University and told me exactly what office to look for. I did go to Bordertown University and applied to the ACP program. I had to take a few classes in the summer and then I would be able to get a job as a teacher, but I had to pay a portion of it to the ACP program. I applied to Fresco School District nearby, and they hired me instantly. I also applied to Bordertown School District, but Fresco called me first. Therefore, I embarked on a different career as an educator.

I applied at Bordertown School District and was immediately called in for an interview. I was hired on the spot and became at teacher at Hawks Middle School. Hawks Middle School is an inner-city school with many at-risk students. I was hired as a math teacher and was given 3 preparatory classes: 6^{th} grade regular math classes, 7^{th} grade Pre-Algebra class and an 8^{th} grade Algebra class. I would study those textbooks every single night trying to get ready for my students the next day. It was a blessing that I loved mathematics and was able to understand it easily and transfer my knowledge to my students. Every day was a new experience with these students filled with challenges and struggles, but also with aha moments and moments filled with success.

In order to be able to teach the Pre-Algebra and Algebra classes I had to attend the 30-hour

Pre-Ap Summer Institute. It was a rigorous training, but it helped improve my mathematics teaching skills. I also took GT training which also gave me various strategies to teach my diverse groups of students. Although I taught mathematics, I never forgot my passion for working with computer information systems. I applied for a program through Intel and was teaching my peers at Hawks Middle School how to integrate technology into their lesson plans during the summer. This program also led me to meet Dr. Butter at Bordertown University and led me to gain a Master Technology Teaching Certificate.

The next opportunity arrived a couple of years later. I had been teaching for about 7 years when I was invited to apply for an NSF grant-funded program. It was called South Texas Math Works, and it was offered by Marcus University and we also got college credits for it towards a master's degree in mathematics and science. I quickly signed up for it and enjoyed teaching Pre-Algebra skills to incoming 6th grade students. I was even more pleasantly surprised when I was able to teach an all-girls class. In that summer program, I had students from Bordertown University come and observe me to obtain college observation hours. We had so much fun working on these hands-on activities with these girls. I remembered one student in particular. She was very smart and her parents were well educated. She went on to become a Pharmacist at a local store.

At this time, I had the privilege of revisiting my old high school mentor teachers, Mr. Ramirez and Mr. Garcia. They informed me about a master's program that they were offering in math and science, and they would accept the credits from Marcus University and would pay for half of it. I immediately enrolled. I taught my middle school students by day and went to graduate school at night. I received my master's degree in 2007 from Bordertown University. Then I felt that I had learned as much as I had to learn about being a teacher and immediately signed up for classes to become an administrator. Again, I was teaching my students during the day and going

to night classes to obtain my certificate in administration. I acquired my administrator certificate in 2009 and applied for an administrator position.

From there, I moved to an elementary as a dean of instruction. There I learned about the foundational skills that students need to master to be able to move onto middle school and be successful. Again, I tried to push the math and science lessons at this new campus. I was there for four years and during my last year, Bordertown school district was promoting STEM activities for younger children. One of our 3rd grade teachers wanted to do it, but was unable to go to the trainings due to her father's health. I offered to go for her and give her the information I gained from the training. I learned how to work with Lego Mindstorms and had a group of 3rd grade students which included 4 boys and 4 girls work on building robots. We ran out of time, but I promised them that the following year I would teach them how to program the robots. There would be no next year. Our school got closed due to budget cuts at our school district.

Then, I was hired by an old friend of mine from Cokely Middle School. He had moved to Pulman Elementary as an assistant principal. Since I had made a good impression on him as a dean, he requested that I be given the chance to interview for a new position at his campus as an assistant principal. This school was an amazing campus and to my pleasant surprise is a STEM focused campus. The school has an electronic device for each student enrolled there. The teachers are trained in various platforms and incorporate their lessons using technology. When the pandemic hit, they were ahead of the curve because they had become experts and adapted quickly. I am blessed to be an assistant principal at this school who embraces science, technology, and math as a way to prepare our elementary students on their way to college.

Findings and Analysis

Aoki (1993) and Olson (2000) "remind us that the lived curriculum is a curriculum of multiplicity, a story of lives as they intersect" (Maxwell and Roofe, 2020, p. 32). As each Latina told their life story, themes emerged that resonated with various intersections of family, culture, race, gender, power, and privilege. The research questions were answered through the presentation of the intersecting themes, highlighting critical experiences in each woman's story as they recalled them. The findings were presented and discussed in greater detail under each research question.

Each of the women described her lived experiences using race, gender, family, culture, power, education, purpose, and privilege as well as the complex intersections of these structures. All four women considered their families and, in particular, their parents influential in the early years of shaping their STEM identities by nurturing their interest in science and mathematics.

Intersections of family, culture, and race: "Andale *mij*a . . . tu si puedes"

Espinoza-Herold (2007) explained, "Educación in the Latin[a/]o family includes manners, moral values, and rules of conduct, in addition to aspirations and expectations for the future" (p. 262). Latina/o parents see academic learning, behavior, and moral values as intertwined and inseparable—all important aspects of their goal of raising children who become good people with strong cultural identities that lead good lives and successfully navigate a society that often constrains them educationally and economically" (p.57) . Yosso (2005) further discussed the concept of cultural wealth and notes that it is "an array of knowledge, skills, abilities and contacts possessed and utilized by Communities of Color to survive and resist macro and micro-forms of oppression" (Yosso, 2005, p.77). The testimonios told by the four participants provide insight into very unique contexts that helps us understand the community cultural wealth (Yosso, 2005) provided by the families for their daughters as they were pursuing an education in STEM. The

women in this study noted aspirational capital, familial capital, and resistance capital in their educational journeys in STEM. Some of the parents provided aspirational and motivational support, but others participated in a more in-depth way. Both approaches had a great effect on their children's STEM educational journey.

A common finding among all participants was the strong emphasis that parents placed on obtaining an education along with planting the seed from an early age of the possibility of going to college. More importantly, parents consistently encouraged their daughters' in their pursuit of an education, even though they had a limited education themselves. This information concurs with findings from Contreras Aguirre et al. (2020) who describe how many Latinas firmly believe that their college education not only benefits them but could also lead to major benefits and opportunities for all members of their family.

Christina chose an artifact about attending her cousin's graduation from a very prestigious university.

> I mean, it's just a logo, but my cousin actually graduated from Stanford in 1994. My family was invited to the graduation and we went. Oh my God, my parents would not stop talking about it. Wow! Like everybody was so excited. Everybody thought, you know, just that idea that you know somebody from here, from our very own Bordertown. You know, one of our family members was able to go to this amazing university and graduated as an engineer. My parents always told me "Hey, like, if she can do it, you can do it too, you know, being a female!" (Christina, Interview Session 1, October 2021)

Jacqueline noted that her parents never really discussed the issue of going to college, but her father made sure that his children would have a good education.

> I guess my Dad, without saying anything, he will say, we'll just send them to a good school so that they can do better choices and it worked for me, my sister and my middle brother. My youngest brother didn't really want to. But he did learn from my father and he opened up a business here in Bordertown. (Jacqueline, Interview Session 3, December 2021)

Regina remembers that at a young age, going to college was an expectation for her and her sister.

> You know 'cause my parents started school and you know they had family and jobs and neither one of them finished college. But I knew it was always not a question of if I was going to college, but what college was I going to go to. It was just understood and with me, my parents never had to push me. I really like school. I always knew that that's what I wanted to do. . (Jacqueline, Interview Session 3, December 2021)

Cecilia also recalls being reminded of the importance of gaining an education at a young age.

> I remembered the lessons my parents taught me about trying to be the best student in school and getting an education that would help me get a good career and help me lead a good life. My dad would give me words of encouragement and tell me "Andale mi hija, tu si puedes". And I never wanted to disappoint my parents, so I always tried my best. I also remembered my parents teaching me about God and to always thank him for all the blessings we were given, each and every day.

> Especially the blessing of good health and knowledge. (Cecilia, Interview Session 3, December 2021)

For all four women, going to college was not a question, it was an expectation which began in the early elementary years. Several of the women were able to obtain scholarships favoring Latino students which provided financial support to continue their pursuits of careers in STEM fields. Family played an important role for the women as they became interested in STEM careers. Early on their families did not know about the many opportunities in science, technology, engineering, and mathematics fields. However, the girls grew up in a close family culture and learned a lot from their parents' interactions. Christina reminisced about how her family would always communicate with each other.

> So, there was always, you know, we always had conversations. We always, you know, we would eat together at the dinner table every day. We always had that constant communication. And for school it was always about, you know, Study, Study, Study! And your school always comes first! So, they were always encouraging me to do better and pushing me. Like during the summer, my parents would work and they would, you know, we would be left alone in the 90s, but my mom would leave us, uhm, book reports. We would have to read and she would make us do book reports on her own. Like she was not a teacher, but she would just like say, "Okay, I want a book report of this book and I want you to find out about this". . (Christina, Interview Session 3, December 2021)

Jacqueline recounted her relationship with her family when she was growing up.

> My mom, she grew up in a different, you know, family setting. My mom will do, let's say I don't know. She will stay home, take care of us, cook. You know, what

> the homestay mom will do. I remember, I will just get home and do my homework and then I will be outside the whole afternoon. (Jacqueline, Interview Session 3, December 2021)

Regina shared a picture of her with her dogs as the first artifact for our interview. She noted that her pets were very important to her when she was little.

> I had one with all of my dogs. That was something that I gravitated towards with just my animals. My uncle had his ranch and my father's side of the family is Puerto Rican, she they would you know, be killing a pig and roasting it out in the open for 10 hours…but I could not participate in it, I could not even see it. So at an early age, I always told my family that I was going to be a veterinarian, so my uncle had his ranch and I would always tell him don't sell it, 'cause when I get older, I could already envision it being an animal sanctuary. So, when I got older and I was going to school, science was just always my interest. (Regina, Interview Session 1, October 2021)

Cecilia states how important her family was in her life:

> In order for us to go outside and play, we would have to do our homework first. Then my brothers and I could go outside and play. When dinner was ready, my mom would call us in. We would sit together, as a family. And my dad would ask us if we had finished our homework and if not, he would offer to help us. I would always ask for him to help me with my times tables and my brother with his spelling words. (Cecilia, Interview Session 3, December 2021)

Another interesting finding that emerged was that these Latinas were motivated by challenge and that challenge was multi-faceted. Latinas face a multitude of challenges from having to live up to family expectations, balancing the responsibilities of life and school, not having equitable access to resources, or sometimes feeling alienated in male-dominated STEM courses. All participants were engaged in resistance capital which "refers to those knowledges and skills fostered through oppositional behavior that challenges inequality" (Yosso, 2005, p.80) when they were trying to build their sense of identity. These Latinas' parents wanted their daughters to succeed in their STEM endeavors, but had reservations when their daughters wanted to go away for college and enter a male dominated STEM field. Villenas and Moreno (2001) discuss the contradictions Latina mothers face as they try to teach their daughters *to valerse por si misma.* It is argued that "the teaching and learning that occurs between mothers and daughters through *consejos* (advice), *cuentos* (stories) and *la experiencia* (experience) are wrought with tensions and contradictions yet open with spaces of possibility. Latinas evoked patriarchal ideologies about being a *mujer de hogar* (woman of the home), while simultaneously negotiating these in discourses about knowing how to *valerse por si misma* (to be self-reliant)" (p. 671).

Valerse por si misma. All women, at one point or another, acknowledged that they would like to be self-sufficient due to their observations of how their mothers were seen in the Latino culture as the stay home parents or nurturers. Unknowingly, this became one of the reasons for obtaining a career that would give them the financial freedom to make their own decisions. They challenged themselves to not only obtain a career, but pursue a degree in a male-dominated STEM field.

Christina recalled being very upset at her dad not wanting her to move away to go to college:

> Now I wanted to get all my ducks in a row so I can come to my parents and say, OK, my boyfriend and I are moving to UTAH and I can you know, saying my prayer and actually it became an emotional like decision, because my dad said "Oh my God like how can you leave?" You know, the traditional, you know Mexican. He said "Like how are you gonna leave without getting married? and then he says "How's that going to look?" and all this stuff and honestly and just like my husband [then boyfriend] was surprised when my dad told him like Why are you stealing her? I'm giving her to you. We were trying to do things right and I don't know, so and that's why I was really upset. I was like, No! why did I go to college. Why did I study? You know? Like, why? If not, I would have saved money, you know, by not going to college and just pop up kids and just like just be there. But no, like I chose to go to college to see, chose to like, go further that so that I can do better for myself. And now I'm being, you know, like held back! (Christina, Interview Session 2, November 2021).

Christina felt that she was being held to a double standard. Her brother was allowed to move to San Antonio to pursue his college education there. But when Christina wanted to move to Central Texas to UTAH University, her dad did not think it was a good idea and convinced her to stay in Bordertown.

Jacqueline was at first hesitant to talk about her mother's relationship with her father and how that had affected her. Jacqueline opened up and shared:

> My mother would always do whatever my dad told her. I would listen and I would notice. So, when my dad would tell me to do something, I would question it. Why should I do that? So, when I married my husband, I did not want him to be like my dad that he told me what to do. (Jacqueline, Interview Session 3, December 2021)

When asked about her parents' encouragement to pursue a degree in a STEM field, Jacqueline noted the following:

> My mother, she was very encouraging. She would tell me "Whatever you want do, I think you can do it." And that's it! In those days, I think were more left alone. You know, you're going to school, then you're doing fine. Okay, continue and that's it. My dad, at the beginning, he was kind of "No!!! Are you crazy??? You're going to live with guys? That's not the right field for you!" (Jacqueline, Interview Session 2, November 2021)

Jacqueline's rebel side came out and decided to prove her dad wrong.

> Uhm, and anyway, I enrolled and I graduated as an engineer. It took me nine semesters to finish, but I did it!!! (Jacqueline, Interview Session 2, November 2021)

Regina also shared the same point of view as she also saw the relationship between her parents as unfavorable.

> So, for that one, what resonated with me was again just knowing that when I had a family, I wanted to be financially stable. I didn't want to have to worry. I always knew I was gonna work. I didn't, you know, I always wanted to have that independence and know that I was self-sufficient. That was a big deal for me, so you know. So, for one of those reasons, I didn't get married till I was 33 years old. I thought I'm going to go to medical school or vet school. I was going to do it and

> also because I saw the relationship with my parents. I wanted to be like, you know, and at that time too it's like it was the man of the house and then that you know the wife and I felt like when you became a wife you kind of lose your…your sense of who you are because you're there to do everything for everybody else and that's what I saw with my mom. And I knew I didn't want that. It's like, well, no. I have a voice too! My, my opinion matters as well. I'm educated . . . I'm making you know, contributing money to . . . to everything. You know to . . . to our finances to our home too so, my voice counts just as much. So I grew up with that kind of, and I don't want to seem like I have a chip on my shoulder, but I knew that I wanted to be self-sufficient no matter what situation I ended up in. (Regina, Interview Session 2, November 2021)

I could see that it was very important for Regina to be self-sufficient and to maintain her own sense of identity. Although, she talked very little about her family life growing up, I know that her parents got divorced and that had a great impact on her having a good career that emphasized her sense of identity and gave her financial freedom to not have to depend on her husband, should she go through the same painful experience as her parents.

Cecilia also remembers feeling the same way as the other women.

> My mother noted that I loved school and loved learning. She encouraged me, as well as my brothers, to try our best at school so that we could get a good job when we graduated. She always made it a point to tell me that I needed to get a very good education, in case I ever got married and had children, and for whatever reason was left on my own, I would be self-sufficient and not depend on anyone else to survive (Cecilia, Interview Session 1, October 2021)

The four women in this study resisted the traditional idea of a wife within their culture. They felt that they needed to obtain their degree in a STEM field and move forward with getting employed to effectively use their higher education to gain their own sense of identity and to have an equal voice in the marriage as their husbands.

Intersections of class and financial opportunities: "The American Dream"

Huang and Paralkar (2021) noted that "family socioeconomic status (SES) reflected a family's position in the social and economic hierarchy and the resources, prestige, and privileges that derive from this position" (p. 63). They emphasized that there has been a long trajectory of research which showed that there was a strong relationship between parental (SES) and their children's success in P-12 education. The Latinas in this study also highlighted a theme important in their life histories- socioeconomic circumstances. Most participants in this study noted that their parents worked and were able to provide well for their children. One participant's parents had a low-socioeconomic status but had the same expectations for their children as the other participant's parents.

Christina's family lived in a middle-class neighborhood. Her dad worked as an auto parts salesperson and her mom worked with city management. Her parents worked for most of their lives to provide a good home for their two children. One of Christina's artifacts was a picture of her encyclopedia set, which she received as a gift as a child. The encyclopedia set proved to be her companion during Christina's summer break, and she would constantly read about science topics that her mother would assign her children when she went to work. Christina showed that she was self-driven when it came to her education even as a small child.

Christina also noted that she had attended a Montessori school when she was younger. She

stated “since I was little, I went to Montessori school and I think it started there. Like, I mean I loved school. I loved going to school.” She said she learned how to be neat and fold her mats and put everything in its place after she was done working with things. When she was older, Christina was enrolled in a STEM magnet school where she went through the medical pathway which paved the way for obtaining her chemistry degree at Bordertown University.

Regina lived in a middle-class neighborhood in Bordertown. Her mom was born here, but her dad was born in Puerto Rico. She only has one sister. Her parents both worked hard to provide a good education for both of their daughters.

> I went to Saint Joe (private school). My parents were middle income, so I know that they really, you know sacrificed a lot to have us go there. And so, I was at school with kids whose parents were doctors and lawyers and business people. And my parents were just regular people with regular jobs. So I saw, you know, the beautiful homes that they lived in. Heard about the vacations they would go on. (Regina, Interview Session 1, October 2021)

Going to private school with these upper-class students made Regina know the importance of getting a good education.

> I felt like if you went into education, that was like the bottom of the career choices for you, because everybody kind of felt like everybody went like business or medical or the lawyer route . . . Yeah, because you know you gravitate towards what’s familiar, so that’s what they saw, so they just fell in line with what their parents did and my parents, they weren’t professional. So it’s like, what am I interested in? What do I wanna do? And you know, I kind of just went with my own interests. I really thought I was going the medical school route and life didn’t

work out that way. (Regina, Interview Session 1, October 2021)

The irony was that even though Regina got accepted to medical school fitting in with the aspirations the upper-class parents had for their children, she rejected the opportunity and made the bottom of the career choices (at the bottom of her career hierarchy list) and became an educator while she waited for something better to come along that would fit her passion for science and helping people.

> I mean of course, my mom hoped that I would be a doctor or a lawyer. So I was kind of you know . . . I think I disappointed her 'cause I was just a teacher. I remember like since my closest friend's dad was a doctor. And so I remember one time my mom made a comment like "Oh I wish you would have been a doctor like Sylvia". You know it was more for her that she wanted me to be a doctor than for me actually wanting to be one. My dad was more like, you know, proud of what I'd done because I started teaching at the university. And so, he was really proud that his daughter was a university instructor. But my mom always felt like I could have done more. (Regina, Interview Session 1, October 2021)

Jacqueline's family lived in a middle-class neighborhood in Mexico. Her parents were born in Mexico and their children were born and raised there as well. Her mom did attend school, but it was more like certification to teach students. She worked as a teacher for a couple of years and then became a stay-at-home mom. Jacqueline's dad had a car parts business. He worked hard to put his children in private school during their elementary years. Jacqueline had a twin sister and two brothers. Two of the siblings still live in Mexico, while the other two live in Bordertown.

> My mom, she went to school in Mexico. It's not a like a full degree, but you do it in maybe two or three years. Education in Mexico, it's a little bit different. Like

> you can come and you will finish high school in only three years, instead of four. You finish the fourth one with like a vocational certificate. So my mom, she taught elementary students in Mexico. My dad had an auto shop. He repaired parts and he also reconstructed parts. Like he would come to North Bordertown or to like Houston and would visit vendors to check their car parts and alternators. He will review them and buy the parts, whatever was damaged. He will replace them and he will paint them and he would sell those in Mexico. Ok, so he created like a little manufacturing company, but it's something small. He was proud that he was making money and he didn't have any education. (Jacqueline, Interview Session 3, December 2021)

With the income that Jacqueline's dad was making at the auto shop, he was able to send them to private Catholic school, where she learned how to speak English, which helped her when she moved to Bordertown.

Cecilia on the other hand recalled admiring the same set of resources that Christina talked about and actually wanting a set of encyclopedias, but had to go to the public library to use them. She knew that her parents had no means to purchase such a valuable set of knowledge.

> Yeah, like my parents were like, they couldn't afford any of that. But they would take my brother and I to the library. So, we would go in there and be all excited. Like before, it's not like today where they say, okay, go ahead and do a research project on whatever topic. Yes, you would have to go to the library. You would have to go through encyclopedias, through different journals and you would need to take down notes because you couldn't take those special books home. It was a lot harder. (Cecilia, Interview Session 1, October 2021)

Cecilia's socio-economic circumstances were very different than the other participants. Her parents moved to the United States in order to give their family a better life in terms of economic well-being and stability. Cecilia remembered that her mom came from a small town called Matehuala, San Luis Potosi, in search of a better life for herself and her children.

> My mother always felt sad about leaving my grandparents and her siblings behind in Mexico. But, she knew that she did not want my brothers and I to have to wake up early in the mornings to pick crops for my grandfather, the same way she did. So, she came to the United States as an illegal immigrant, but applied for citizenship and obtained it. Even though, she did not become rich, as many people believe that is what the American Dream is, she did find a job and sacrificed so much, so that my brothers and I would obtain a good education that would lead to better opportunities for our families. She was always content with her job and knew that it was important because it was getting us one step closer to fulfilling our dreams. My father also had a stable job, and together they bought a lot, which became a home where we lived a good childhood and where we learned the value of education. My parents did not have an education, so they settled for minimum wage jobs that would put food on our table and pay for our bills. In our area, we were considered at-risk and had a low socio-economic status, which did help us obtain financial aid and grants that would help two of my brothers and myself obtain a college degree. So, according to my parents, they did fulfill the "American Dream." (Cecilia, Interview Session 1, October 2021)

In some respects, the women's families believed that education was truly the key to success and the only way to climb up the financial ladder. They understood that working hard and being persistent in getting a good education would provide their families a better economic future. Making their daughters believe in themselves and believe that they could do better, would eventually help them become stronger as a family. Contreras Aguirre et al. (2020) concur and state that "the motivation for many Latinas is the idea that they will be able to provide some financial relief to their struggling families. The *papelito* [degree] becomes much more than their own future; it also includes her family, and her future family. Therefore, there is a noticeable dilemma that appears for the Latina pursuing a STEM career" (p. 42). On one hand she is expected to be a caregiver and be able to raise a family, while on the other hand she is expected to pursue a career and achieve a higher education.

Intersections of legality and power: "Proud of becoming an American citizen"

Legality issues, as well as other struggles helped some of the Latinas build resilience. Cecilia recalls a time when she was young and they had gone to Mexico because her grandmother had come to visit her mom and grandchildren, but she could not cross the border.

> We went to a plaza and talked to my grandmother and had a little picnic. She was so happy to see us because she hadn't seen my mother in years. When we were crossing the bridge back to Bordertown, my mother got detained at the checkpoint and was told that she could not cross. My mother asked the agents why not and they had told her something about her legal status. I remember I was scared for us and my mom. She asked one of the female agents if she could call my dad to come for us and they did. We waited several hours and after going back and forth with different agents, they let my mom come back to Bordertown. I did not know at that

> time that my mom was in the process of getting her citizenship and could not go over to Mexico, until her citizenship application was approved. *Gracias a Dios*, this happened several months later. We went with her and saw her and a group of people say the Pledge of Allegiance and get their certificates of citizenship. I had never seen my mother so proud of becoming an American citizen. (Cecilia, Interview Session 1, October 2021)

As Cecilia was growing up, she noticed that her parents were different from those of her classmates. Whenever notes or report cards got sent home, Cecilia needed to translate things to her parents. She became a language broker at a very early age and that made her feel good because she could help her parents. Cecilia's mother did not speak English at all and her dad spoke limited English. However, Cecilia's mother did ask her for help when she began learning English and studying to pass her citizenship. Even though she learned it well enough to obtain her citizenship, she never liked to speak it. She could understand what we would say to her, but she would be embarrassed because of her strong accent and because she did not know all of the words in English. She would always tell her children that she was very proud of them because they knew both languages and could easily transfer from one language to the other. She would also tell them that the more you know, the less people will put you down or take advantage of you. This concept helped Cecilia learn that being bilingual is a great asset and something to be very proud of. Her parents constantly kept reminding them that knowledge is power and that education can open many doors for you. Stevenson et al. (2019) note that "when Latinos adhere to their culture and language with pride, they can freely and purposely use their bilingual, and sometimes multilingual, linguistic resources, including personal ways of expression that project their home and community culture, as a means to make sense of their context and to facilitate their interactions in a variety of social

settings" (p. 4). Stevenson et al. (2019) also stated that "serving as language brokers has been a means to strengthen their familial relationships, re-affirm their support networks, and build their sense of efficacy as problem-solvers" (p. 8).

Jacqueline can relate to the language struggle that Cecilia's mom went through. Jacqueline got her degree in the engineering field, but in Mexico. She worked for four years in a maquiladora and got married.

> So, I work for four years, until I got married. I got pregnant and I moved to Bordertown because my husband lived there. If I wanted to continue to be working as an engineer in this area, I will have to, uhm, challenge a test so that I can be like a certified engineer, right? But in that time, I'm talking about 2000, I didn't know much English, so I wasn't sure to be challenging any type of test. It took me maybe four years to start thinking. Okay, well I had my daughter, she was four years old and then I was pregnant again and said let me see if I can do something else. (Jacqueline, Interview Session 2, November 2021)

Jacqueline became a citizen through her marriage to her husband. She had already obtained her engineering degree and was applying her knowledge at a local maquiladora in Mexico. However, if she wanted to obtain work in the same field in the United States, she would have to be certified here. Her struggle with language, and then her duties as a mother, made her second guess her ability to become an engineer in this country as well. If she had had the courage to challenge the test, she would have had more power in terms of education, and socio-economic status for her and her family.

Christina and Regina did not note any struggles with legality and power because their parents were United States citizens and had obtained a little more education than Cecilia's and

Jacqueline's parents. However, the experiences that both Cecilia and Jacqueline went through helped them become more persistent and reminded them of the greatness of education. This education could enable them to obtain economic upward mobility for themselves and their families. Reminiscing about these hard times of legal challenges and of limited power gave the Latinas strength to face further struggles in their life histories.

Another important finding that emerged was that these Latinas' STEM degree gave them a position of privilege, but it also served as a way that marginalized them.

Intersections of social class and education: "When I grow up I want to be..."

McLaren (1994) stated that "knowledge acquired in school or anywhere, for that matter, is never neutral or objective, but it is ordered and structured in particular ways; its emphasis and exclusion partakes of a silent logic" (p. 275). The public-school agenda was to educate the masses in order for each individual to be a productive citizen in our society. For most of us, that meant working for those in the higher levels of the social stratification. This social stratification was a ranking of people or groups of people within a society based on factors like wealth, income, education, family background and power. Most people believe that everyone has an equal chance at being successful through hard work and talent. This chance can increase a person's social mobility from one status to another.

However, in this country there was a dominant culture, that of Eurocentric white people. They are "in control of the material and symbolic wealth of society" (McLaren, 1994, p. 275). Reigle-Crumb (2019) used the theory of categorical inequality between social groups and noted that Tilly (1997, 2000) "proposes the concept of opportunity hoarding as foundational to understanding inequality. Within the opportunity hoarding framework, members of an in-group secure and subsequently maintain access to a resource that is both limited and highly valued- one

that provides an advantage at present and into the future" (p. 134). Sociologists of education note that opportunity hoarding can be see when "groups create social advantages through some form of educational segregation and thus essentially gain control of education as a highly valuable resource" (Reigle-Crumb, 2019, p.134). The opportunity being hoarded in this instance was access to equitable STEM education.

Filippi and Agarwal (2017) stated that there was ample research that showed that girls can be blocked from learning and participating in STEM classrooms based on stereotypes about their abilities. They note "different countries have varying social and cultural perceptions of traditional gender roles and can therefore hold prejudices against women pursuing STEM fields" (p. 260). Therefore, it was imperative that parents and teachers foster and develop a girl's natural interests and abilities which will help define their STEM identity.

The Latinas in this study developed a STEM identity early on in their educational journey. Carlone and Johnson's (2007) model described science identity as "a changing context-specific intersectional identity that interacts with racial, ethnic, and gender identities; develops over time; and is composed of three core, somewhat overlapping dimensions: competence, performance and recognition" (p. 3). Rodriguez et al. (2017) found that "STEM identity development was influenced by the ways in which Latinas in college came to recognize themselves as possessing a STEM identity and the way in which others also recognized their identities. Students based their self-recognition in how they saw qualities they associated with being a STEM person reflected in themselves. For most students, self-recognition, or reasons for self-identifying as a STEM person, was rooted in their enthusiasm for learning disciplinary concepts, ability to innovate and think critically, and their academic persistence despite struggle. Students often viewed their own struggles and persistence as a way to overcome systemic inequities for Latinas in STEM. A major

concern for a student who identified as a STEM person was identity loss" (p.7)**.**

> As students within this study alluded to, Latinas, as women of color, experience a double bind in which they feel oppressed and marginalized based on their gender as well as their race or ethnicity, an issue commonly acknowledged in the literature. (Rodriguez et. Al, 2017, p. 15)

Education starts at home: "I practice times tables with my dad". All four women fondly recalled early memories with their families, learning about life science, learning mathematics, building projects, and gaining encouragement to pursue their academic endeavors. Regina remembers being very young, around 6 years old, learning that she was fond of animals and would like to take care of them instead of hurt them. Regina stated "at an early age, I always told my family that I was going to be a veterinarian. So, my uncle had his ranch and I would always tell him don't sell it" (Regina, Interview Session 1, October 2021). Jacqueline remembered learning how to multiply because her mother practiced with her after school. She said "when my mom was in Mexico, she already wanted me to know my times tables" (Jacqueline, Interview Session 1, October 2021). Christina's earliest memories were of building projects on her own. She stated "in the summers we would watch a lot of like PBS kids and there was there would be a teacher. They would have science experiments and I would always try to like replicate them and try to do it on my own" (Christina, Interview Session1, October 2021). Cecilia remembered her parents' encouragement of academic endeavors "they wanted for us to go to school and have an education, so that we could have a better life than they did. There was the expectation that we would all graduate from high school and when we got close, that we would go to college" (Cecilia, Interview Session 1, October 2021).

All four women remember how a STEM field was a key foundational knowledge encouraged by their parents. Christina remembers encouragement in science:

> I love that with science vocabulary you could explain, you know, understand things that are hard to understand. Wow, like since I was a really young kid, I would always I love to see how things worked. I'd love to see you know behind the scenes and just kind of uhm. Just getting more of understanding. Like I was very curious as a child. I wouldn't take things apart. I wouldn't do that because I . . . I feel like I was more well behaved and were put together with that, but I just I was always very curious and I would always ask question. And my mom would always tell me "Look at your encyclopedia" and "How does this work? Go check in the encyclopedia," so I credit a lot of that like, early curiosity and knowledge with experimenting with that. (Christina, Interview Session 1, October 2021)

Jacqueline recalled being encouraged to learn the basics for engineering from her father at his auto shop:

> And then my dad also had a like a shop and he will fix things. Well, it was more than a shop, it was something dealing with remanufacturing like certain parts of cars, right? So I thought, well, I think that makes money. (Jacqueline, Interview Session 1, October 2021)

She learned how to count money and take measurements and make sketches of her father's auto parts in his business.

Regina recalls learning about science from being outdoors with her father:

> Since science was my interest and that wasn't the norm. But it was like really fostered in me because I spent more time like the outdoors, 'cause my dad was a

> hunter or fisher. We'd go out so I could name the fish and the, you know different things like that, so that aspect I knew well and I always loved science. (Regina, Interview Session 3, December 2021)

Cecilia's felt that her parents could help her with math, but her dad usually took the initiative.

> My dad worked really hard with me and I practiced learning my multiplication tables with him because he didn't want for me to be like him and not finishing my school. (Cecilia, Interview Session 1, October 2021)

She also remembers helping her dad get the correct size of wrenches when he was fixing his truck. That's when Cecilia first recalled learning about fractions.

Cecilia always liked helping her dad and she would remember that he would be the one to help her with her projects. He was good at building things and taking measurements.

> Sometimes I felt that my dad was living his childhood through my experiences. He would be always be willing to help me build whatever I needed for my projects. We didn't really have a lot of money, so he improvised by bringing things that he found from work, like wooden boards or different types of chords and light bulbs that we could use for my science projects. He would help me measure carefully with a ruler and would offer to paint things for me and help me take them to my class, so that my projects would stay intact. He would be so proud to help his daughter. (Cecilia, Interview Session 1, October 2021)

These positive learning experiences can be viewed through the social cognitive theory that states that "human behavior is primarily explained through self-efficacy beliefs, outcome expectations and goal representations. Self-efficacy beliefs refer to people's judgment of their

capabilities to organize and execute courses of action required to attain designated types of performances" (Bandura, 1986, p. 391). Self-efficacy has the strongest influence on behavior since most people will not perform an activity unless they have enough confidence in their own ability to perform a task. This confidence can define "a person's choice of activities, including educational choices, as well as one's effort expenditure, persistence, thought patterns, and reactions when confronted by obstacles" (Yazilitas et al., 2013, p. 527). These experiences led the Latinas to have a strong sense of self-efficacy.

The women remembered having positive experiences learning math and science and looked forward to their future education and possible careers. The STEM seeds of knowledge were planted early and without knowing by their families and nurtured by their fathers. The women also remembered that their Latino culture had positive influences on their educational experiences, since Latinos foster close knit families.

The Latinas in this study described their educational experiences in a positive manner. They recalled important milestones in their STEM journeys as they were sharing their stories of success along the way. The four women prepared for college through their academic coursework without even knowing. The two Latinas that went away to college found a space where they felt safe and right at home with a new found "family" Since the Latinas did not know how to navigate the higher education and STEM education pipelines, they explored their career options though university sessions or peer mentors. They were also excited for their future careers which helped them continue and progress through the STEM educational pipeline. One common negative experience that these Latinas encountered while navigating the STEM pipeline was microaggressions due to their gender roles.

Preparing without knowing: " I never really thought about that, I just did it." When asked about how their journey in STEM began, the Latinas could not remember a specific activity or project that they had done in school. Most of their science and math experiences began at home with their parents, and they remember feeling proud of themselves because they were good at math or science, earned high grades and getting help from their parents because they understood the language of math or science.

When they went to high school, the girls prepared for college and a STEM degree without it being intentional. They were just excited about taking STEM classes in their schools. Christina recalled going to a magnet high school and having an early interest in the medical field.

> I remember then, um up until high school, I decided to like go to a magnet school. So I went to Higher School for the medical field, for the medical program, right? So that's where I thought I wanted to go. I was in the medical classes. So, I did several dissections there. I also like remember when we first learned to use a microscope. That was one of the things that I wanted to look at right away. So, I went through all the medical classes, right? I had the whole curriculum and I participated in like Health Occupations Students of America. I did biomedical debate and I took anatomy and physiology. So I was very into it. I did my shadowing with a dentist, so I did that for a while, but it turned out like it wasn't really for me. (Christina, Interview Session 1, October 2021)

Even though Christina took all the coursework for the medical pathway, she took various STEM classes without even knowing that they would be useful in preparing her for her STEM journey towards obtaining a chemistry degree at the college level. Since Christina followed the medical pathway, her degree plan had most of the upper level science courses that she needed to

do well at the undergraduate level in college.

Jacqueline did not know what STEM pathway she wanted to pursue for a career, especially in her home country of Mexico. Jacqueline only knew that she was good at mathematics.

> I know I was good in problem solving and now it's not like a problem, solving a math problem. So, I found my own way to learn and from there, like, nothing was hard for me because, Okay, I know I am going to find a way to know for every assignment, homework or test. So, I had a year to choose a pathway after high school. I chose exact sciences, right, dealing with physics and mathematics. I knew I was good with numbers. I wanted something challenging, so I decided on the engineering pathway which was like in the STEM area. I would be learning about math, science, especially physics and chemistry. So that's what I did. I think that was one of the turning points for me, to know I'm gonna embrace that part that I know this because a lot of women are smart, right? I don't know, but I have that inclination for those types of jobs, right? (Jacqueline, Interview Session 1, October 2021)

Even though Jacqueline didn't know what she wanted to do as a career, she chose it by process of eliminating the other fields which were too easy and focused instead on her forte and embraced her self-efficacy in a male dominated field.

Regina knew since she was a child that her interest revolved around science, specifically life science because of her love of animals.

> I had so many interests that I didn't know where to focus and growing up. I wanted to do zoology and then I was thinking microbiology. When I was in high school, the counselors didn't guide me. I went to Saint Joseph. So I was at school with

> kids whose parents were doctors and lawyers and business people. Yeah, because you know, you gravitate towards what's familiar, so that's what they saw, so they just fell in line with what their parents did and my parents weren't professional, so it's like what am I interested in? What do I wanna do? And you know, I kind of just went with my own interests. (Regina, Interview Session 1, October 2021)

Regina took classes in high school that she knew would get her one step closer to becoming a veterinarian when she got to college.

Cecilia didn't know what classes she needed to take, but since she began taking advanced classes in middle school, her counselor advised her about taking Pre-AP classes in high school.

> I remember when I moved onto middle school, my love of math and science was nurtured even further. I also discovered keyboarding, which would help me tremendously with my passion for computers. When I transitioned into middle school, the counselor talked to my parents about placing me in Pre-AP classes because I had gotten good grades in elementary. My parents didn't know what that meant, but I am glad they took the counselor's advice and enrolled me in Pre-AP classes. When I moved onto high school, I talked to my counselor and they pretty much continued placing me into honors classes because I had excelled in middle school. I never really thought about preparing for college, I just did it. (Cecilia, Interview Session 1, October 2021)

Cecilia soon found out that high school was different when you were in advanced classes. Students became more competitive. Everyone in the class wanted to be valedictorian and that made her try her best in all of her classes. She wanted to be up there with her friends in the top 5% of her class.

Parker (2014) performed a study on a Borderland called Rockland Middle School, located in the Mid-Atlantic region. The school had over one thousand students which were 31.2% African American, 12.0% Asian, 28.6% Latino/a, and 2.3% White. The school had three academic tracks for students: magnet, gifted, and regular. According to Parker (2014) tracking creates school-imposed Borderlands for students according to perceived academic ability. Jeanne Oakes (1990) in Parker (2014) stated that "tracking policies provide different groups of students with unequal access to resources, such as well-resourced classroom and rigorous curriculum" (p.322). Tracking can also create unequal opportunities in science for students which results in unequal levels of educational and occupational attainment. Luckily, for these Latina girls, they were tracked into the high ability group and were able to prepare for their college education without knowing.

Costa (1995) noted that "when there is a congruency between students' worlds of family, friends, school, and science, students, depending on their relationship with science, can be described in one of five ways: potential scientists, other smart kids, I don't know students, outsiders, and insiders-outsiders." Parker (2014) proposed that "we should holistically examine school structure, practices in science classrooms, and culture. This will allow us to find ways to break down Borderlands and include people who have not historically been part of 'science for all'" (p.331). Gallard (2008a) in Parker (2014)concured and proposed that "we examine the complex and interwoven contextual factors (structure, culture, and language in schools) that lead to the marginalization of Latinos/as, and that a holistic integration of these factors is an absolute necessity" (p. 331).

Intersections of culture and gender: "The only female"

Growing up at home, the women did not feel isolated or inferior because of race or gender. Most of the people who live in our area are Latinos. On the other hand, culture was celebrated and each had pride in being a Latina. As described above some women were practicing mathematics problems through application. The women were equally challenged as their brothers at home. However, some gendered interactions differed from their male siblings, particularly for their culture. Christina's parents were opposed to her moving away to college without getting married first, but her brother was allowed to do so. Cecilia's parents also did not want her to go away to college, but her younger brother was encouraged to do so. Jacqueline's dad questioned her choice of career pathway into engineering where there would only be men working there, while her two brothers were allowed to choose any career of their choice without question. However, these women were treated intellectually equal to their brothers. This equal treatment made them more confident in taking math and science courses at school. These women were in some way sheltered from stereotypical beliefs about women not being good in STEM fields and helped them become resilient from these deficit beliefs before they went into college.

In college, however, these women did get to experience these deficit beliefs. Each woman had a racialized and gendered identity of being a Latina in predominant male fields. Jacqueline remembered how her undergraduate experience in engineering was male dominant.

> Being a... in those years, being a girl wasn't only for, you know how pretty you look and how going to, you know parties, and I was thinking about something more challenging for me. Right and when I was, I saw, you know, I had a lot of friends and I think only me and another girl we went to engineering. Everybody else, they did something else right, like go into medicine and business. So when I started

> college and this is something that I'm never going to forget, also is that teacher or the professors there will say if you are …because I was the only girl in the class right…and they said 'this is, uhm, I don't know mathematics for the electrical engineering classes, so if you're on the wrong class, you may exit now'. And I, said OK, no, I'm and I knew it was my class right? And then I will stay but, I think I got it like from three teachers. So OK, if you're in the wrong class, you know you can, you can go and look for the correct one. And that was, you know, like it was kind of overwhelming in the in the beginning, because I didn't have any friends and I was the only girl and you know, I will see that the guys would, you know, talk to each other and they were just not talking to me. And until I started, you know, making friends, but that was… it took me a year, until third semester to make friends. (Jacqueline, Interview Session 1, October 2021)

The experience of being the only female in a class of 20 students felt "overwhelming" and Jacqueline remembers feeling lonely but knowing that she had what it takes to be an engineer made her decide to stay in the engineering program. Still she navigated many other instances in her career understanding the she was one of a handful of female Latinas in the room and that made her proud of herself.

Cecilia, who completed a bachelor's degree in Computer Information Systems had a similar experience when she was attending UTAH University. She remembered:

> At UTAH University, my friends were pursuing degrees in the social science fields like teaching and social work. I thought that was too easy for me, so I decided to pursue a degree in STEM, computer science. So, I attended UTAH University for a year, but I did not have a good experience in the program. Most of the students

> were male. I remember being in a computer science class of about 200 students, and it was being taught by a teacher assistant who was Hindu. I could not understand his accent and when he asked if we had any questions, I raised my hand, and they took down my student number, did not care about my name, and told me they would get back to me in about a week. I also remember going to the computer lab to take quizzes, but also male teacher assistants were there and were not very helpful. That negative experience compounded with the fact that I could not see my parents until December and then until May because they had to save enough money to go for me, made me so homesick and discouraged that I decided to come back home. (Cecilia, Interview Session 1, October 2021)

Cecilia encountered challenges that intersected with race and gender at UTAH University. However, leaving UTAH University did not deter Cecilia from pursuing her dream of obtaining a degree in STEM. She moved to Kingston University which was closer to home. There she felt more at home because there were many more Latinos in her classes and those classes were smaller. The professors also welcomed students in person, which made Cecilia feel more "at home" in this setting. She also joined a Latino club, where she met other Latinas in her field, which provided the support and encouragement she needed to succeed.

Christina encountered the same experience when she was pursuing her bachelor's degree in chemistry.

> Uhm, so when I graduated? I'm like, OK, well I know I'd do something in science. Uhm, I started off with biology. It was not as fun as I thought it was going to be so I ended up with chemistry actually. So my chemistry lab, I loved it, and my professor kind of took me under her wing and was like 'Oh my gosh like wow like

> I see that you're very interested in this and you know want to change your major and I'm like, 'OK, yeah' So, I just I loved it. We were more interested in chemistry. In my class, I believe we had by the time we graduated, I think it was, I want to say was like 8 no more than 10 people like students you know and I think I was one of three girls. One of three girls, and I think that actually graduated with exact same degree, it was only two of us. Yeah, yeah it was very rigorous. It was very difficult. (Christina, Interview Session 1, October 2021)

Christina noted that there were fewer females in her chemistry classes, but she didn't think much of it. She knew that she had what it takes to be there, in those classes, along with her male counterparts and tried her best to stay up to par with her grades. It also helped that Christina happened to love science and understood chemistry content very well. She is a Latina who is confident in her skills and in her identity as a scientist.

Regina encountered a similar experience, but even before going to college.

> So, I had an interest in that (biology) and I really wanted to go into that field. I was back and forth. At that point, as I got older between medical school and vet school and if I went the medical school route, I was going to go into radiology. And I was talked out of it . So, I was told it was a male driven field. (Christina, Interview Session 1, October 2021)

Even though Regina was discouraged from pursuing her career in a STEM field, she persisted and knew that she was smart and had a passion for science, especially biology. She did enroll at ATM University, and even though there were more male students in those classes, she still did well and obtained a degree in a STEM field, but at Bordertown University.

Gallard Martinez et al. (2019) were perplexed about why few Latinas experienced success

as they made their journey through the STEM pipeline. They conducted interviews with successful Latinas, and then delved much deeper and found that "their individual experiences, including overcoming adversity, assisted them in creating filters such as resiliency, to make sure of their worlds both in and out of school" (p. 1082). They also found that they had two things in common: the participants identified themselves as Latinas and they were successful as students in their journey through STEM pipeline and as professionals in STEM fields. The participants' resiliency "manifested as a complex composite of individual characteristics based on experiences" (p. 1082). Gallard Martinez et al. (2019) noted that they used tactical understanding to obtain a more individualized and contextualized picture of the stories being told. Through these stories, they realized that "not only did Latinas in the study read the sociocultural landscapes, but they also developed tactical understanding of limit situations and the CMFs that helped them contour their landscapes" (p. 1083). The Latinas in the study are "exemplars of resilience because they have been able to recognize CMFs and develop appropriate strategies to both counter negative CMFs and to embrace positive ones" (p.1083).

Intersections of education, purpose, and privilege: "Intentalo y veras que te va a cambiar la vida"

Delgado Bernal et al. (2012) displayed a "Chicana/Latina *feminista* sensibility and attempts to situate the researcher-participant in a reciprocal relationship where genuine connections are made between the researcher and community members" (p. 366). In this study, I was both researcher and participant, a formally educated Chicana/Latina who documented her own collective story in or out of academia. This concept challenged the dominant notions of who can construct knowledge. Delgado et al. (2012) emphasized that "there have been important discussions around the idea that attaining a privileged status might remove one from the possibility

of writing one's subaltern or marginalized life" (p.366).

> Some scholars point to the idea that the very possibility of "writing one's life" (Beverly, 2005, p. 548) implies that the narrator is no longer in the situation of marginality and subalternity that her narrative describes… if the narrator has attained the cultural status of an author (and generally speaking middle- or upper-class status), she has transitioned from the subaltern group identity to an individualized identity. We argue that for most Chicana/Latina scholars this is not the case: A group identity and group marginalization continues to exist in academia even when we have attained a relatively privileged status. (Delgado Bernal, 2012, p. 111)

Education was an important goal for the Latinas and their families. They took this commitment very seriously and worked hard to maintain good grades and learn many valuable skills along the way. When these Latinas attended college, their lived experiences led them to value education even more. These Latinas reflected on how education had improved their potential within society and secured themselves a place of privilege. However, these Latinas still feel humbled by their lived experiences and can relate to being marginalized in the male dominated STEM work force which forced them into a new career field, that of education.

A distinct finding that emerged was that teaching a discipline in STEM education was a complicated choice, but it was not always a first choice for all of the Latinas that participated in this study. After graduating from college in a STEM field, all four women became educators. It is important to note how these Latinas navigated their classrooms and how their STEM identities helped them encourage and push their students to become better and more successful people. They passionately believed in the importance of education and are paying it forward to future Latinas

and making them believe that they too can be a STEMinista. They all believe that a girl's STEM education matters, and it should be accessible, empowering and discovery-led. The STEMinista Project is an initiative started by the Michigan Science Center to connect girls to role models as a resource in order to see themselves in STEM.

These Latinas have used navigational capital during their STEM journeys as students and then during their STEM journeys as educators. Scholars have examined individual, family and community factors that support their successful navigation through the educational system (Arrellano and Padilla, 1996, p. 485). These Latinas built resilience as they had to re-assess their career options. This resilience has been recognized as "a set of inner resources, social competencies and cultural strategies that permit individuals to not only survive, recover, or even thrive after stressful events, but also to draw from the experience to enhance subsequent functioning" (Stanton-Salazar and Spina, 2000, p. 229). Even though the Latinas did not enter their chosen STEM field as a career, they are now thriving in their alternate careers as educators.

Christina obtained a STEM degree in chemistry. She wanted to apply what she earned through her STEM degree. She noted " I was very nervous but excited. You know, just for something different or something that I can actually do with my degree." She had done several internships: one with the city's health department and testing water samples for mosquitos, another in a lab where they made creams and lotions for medicinal purposes, which she really liked. She did get an interview with the local utilities company. She recalled "So I went to that interview and I just tried to cast the net wide." Since her interview panel was made up of men, and they took a while to offer her the job, Christina did not wait for the offer that she had worked so hard for and instead settled for the job offer that came first as a paraprofessional in a classroom. Although her life experiences led her away from a STEM career, education has always revolved around her love

of science. Christina is currently a 5th grade teacher at an elementary school. While most of her peers shy away from teaching science and focus on the testing areas such as math and reading, Christina makes it a point to do hands-on science lessons with her students. She piqued their curiosity through research about life science and was involved in extra-curricular activities with her students that involve coding and robotics.

> I think it started like as a curiosity a lot. And, you know, just trying to learn more and you're just looking at books and pictures. I guess, documentaries or like we loved science videos, you know like the next day we were anxious to see more like PBS or something educational, right? And I always remember just like really loving to just learn about things that I never knew or how they worked. And so, I think that just carried on with me. As I got older, as you know, got more into technology, I still love learning new things with technology. I wanna find the best like websites and best tools that I can use in my classroom to implement, you know, for my students. I try to tell my students, encourage them to be curious, and to be inquisitive right, and to also communicate. Because I feel like with a background in science, you need to be able to communicate. You know your findings and you know what's in the world. That's why I tried to have open communication with my students and I want them to like share what they've learned. You know, how can we make things better through problem solving, you know? And I feel like that was embedded in me every day. That is how I grew up and how I learned to go through my schooling from when I was a child in grade school through my college years. I try to have them (my students) use those skills. And so that's how I guess we teach how we were taught. (Christina, Interview Session 2, November 2021)

Christina also reflected on how she tried to infuse science with the other subject areas.

> I tried to incorporate other things too. I mean like in reading, I would bring in some math and science. I would try to teach across the curriculum. We even had a science lab that we would go through an appointment. Personally, I would love to have just, okay, I'd be the science teacher for the lab. I would teach all of their labs, and that would be like my dream job!!! (Christina, Interview Session 2, November 2021)

Jacqueline obtained a STEM degree in engineering in her home country of Mexico. Although, she loved the challenge and empowerment of being only one of two female engineers in the maquiladora where she worked and implemented the knowledge gained from her degree, Jacqueline had to come to the United States in search of a better life for her new family. She lacked the confidence of being able to challenge the exam to become an engineer in Bordertown because of the language barrier. However, Jacqueline's new career in education gave her the confidence to learn the English language and go back, in a sense, to engineering. I asked Jacqueline "how did it feel like going from having an engineering degree to becoming a teacher?"

> It was kind of weird because I was nine months pregnant with my son, who was born on August 25th. I got interviewed on July 1st and I was so excited about getting a job. I was kind of young at the time. My English wasn't that good and I still needed to practice more. It was kind of bad and I was so thankful that I had a job because I was thinking I don't know how I'm going to explain math in English when I'm not that fluent. But you know, little by little, I started practicing and it took me like a year of not being afraid to explain. You know, I always had it in my mind because English is my second language. But I was not afraid to make

> mistakes because that never bothered me, but I was afraid to say an inappropriate thing or say something that could be taken as an offense or as an insult. But the girls at Link Park, they were really nice to me. My students would mostly speak Spanish, but my co-workers, they didn't really speak much Spanish, so I was forced to learn. So, I started and little by little, I became a little bit more confident and more fluent. During my first year, they told me this is your room. Those are the geometry and algebra books, and those are the physics books. Call me if you need anything. But by my third year, I was teaching other teachers. So, because I always think like an engineer, I always like to facilitate the work for me. I can do this better and I find ways to make things easier for me. And since I have always been good with technology, I thought to myself, I can do this! (Jacqueline, Interview Session 2, November 2021)

Jacqueline had a great opportunity to go back in to engineering by teaching engineering concepts to students when she transferred to a new magnet school. I then asked "how difficult was it to prepare the lessons?"

> The math or the engineering? Okay well what I'm teaching right now is Project Lead The Way. They have several pathways and engineering is one of the pathways. In order for you to teach those classes, you have to get a certification. And once you complete the actual training, you can teach the courses. You cannot teach without the training. The reason is because you have to do the activities before you teach them. But in my case, I started teaching them first before I had the training. It was difficult the first year because I didn't have any clue about teaching aerospace engineering . . . I didn't know anything about aerospace, and

> the first year was kind of difficult because I was reading about the activities, the procedure or steps and the materials. I was watching videos and it took me a while. But once I went to the summer training, I got it! Especially the robotics part. Jesse was excellent for robotics. As a matter of fact, he taught me some things. It was a little bit difficult, but in order for students to do the activities, you have to explain it well because if you don't, then the kids are not going to be successful because they're not going to understand what you do. (Jacqueline, Interview Session 2, November 2021)

Jacqueline realized that she was having difficulty teaching her first engineering class which dealt with aerospace, but she was able to use what she knew about basic engineering skills and taught herself through reading and watching videos. She was then able to teach the class before having the formal training needed to be a successful teacher. When I asked Jacqueline if she had the opportunity to go back into working as an engineer, after teaching, would she take it? She said "Oh, yes, definitely! I miss being able to go anywhere and work on a project with my team. Nowadays, I have to worry about going somewhere for 5 minutes and finding someone to take care of my school kids."

Regina always wanted to be a veterinarian. Her love of science began with her home life, going to her uncle's farm, and caring for animals. Regina did obtain a STEM degree in Biology with a minor in chemistry and her goal was to become a veterinarian or go to medical school. However, she was discouraged by a male veterinarian that she worked for, and her benevolent heart that wanted to help as many animals as she could would turn out to be impractical for her business. Ironically, even though she did not make the cut for veterinary school, she did get accepted into medical school. She recalled:

> Like for a while I was floundering. Like I wasn't sure what I wanted to do because when I got my acceptance letter to medical school and then I got the opportunity to work in research with another doctor, I didn't want it! I wasn't excited. And so for a career that's so demanding, I thought that's something I've got to be passionate about and 100% all in, and I knew I wasn't. (Regina, Interview Session 2, November 2021)

Regina came back to Bordertown and transitioned into the education field. She began as a paraprofessional, then became a teacher, got her master's degree in mathematics and science as well as her principal certificate as she has grown in her professional field. Regina is currently working as a Math Specialist for Bordertown school district.

> It (STEM degree) really did give me a lot of opportunities, like when I was, you know, trying to decide what to do, or it opened doors like just to get other jobs before I started.. I don't know if it's because I was a female or because it was a combination of those two degrees, but thank goodness I've never struggled to, you know, find a place where I wanted to work. I never had to take a job because I had to. There was a job because I wanted to, so it afforded me a lot of options. (Regina, Interview Session 2, November 2021)

Regina reflected on the point in her career that she is in right now as a Math Specialist.

> I know their struggle (teachers), definitely. So, I've been very fortunate to have really good mentors. So, my experience has been wonderful with everybody I've been fortunate enough to work with and learn from. (Regina, Interview Session 2, November 2021)

Cecilia has always been fascinated with technology. She learned about computers and wanted learn how to program them. During high school, she contemplated becoming an electrical engineer but was dissuaded by the number of male students in the gatekeeper classes. She did, however, pursue her interest for computers and obtained a STEM degree in Computer Information Systems.

> I continued my STEM journey after I graduated from the university. But life takes us through interesting twists and turns as we struggle to define who we are. I remember going to my 1st interview for a computer programming job with an accounting firm. I was nervous but excited at the same time with my degree under my belt. I was walking after taking the bus and was confident I was going to get the job. However, when I finished, they told me I didn't have any experience and were looking for someone older. I had a few other interviews, but they pretty much went the same way. Discouraged but needing a job to help out my family, I worked with my mom at a secondhand store and then at HEB while I found a career where I could implement what I had learned from my college experience. (Cecilia, Interview Session 2, November 2021)

Cecilia met a friend who was teaching at Bordertown school district and told her to give teaching a try.

> I ran into a high school friend at the mall and she told me she was a Spanish teacher and that she really liked her job. She told me to give teaching a try, that it paid good, you get the summers off, and that it was a very rewarding career. So, I went back to college and inquired about this option. I enrolled in the Alternative Certification Program at Bordertown University and paid for these classes with the

> money that I earned through my mom's work. After I finished the classes, I was able to sign up for an internship as a student teacher, where I would get paid, but a portion of it would go to the ACP program. So I began teaching in a nearby school district. On my first day, I woke up super early to drive 20 minutes to my first teaching job. I was given a huge binder with scripted lessons and was given barren classroom. It was then that I realized and asked myself, "what am I doing here?" I have never taught in my life and here come my class of 8th grade students who were depending on me to guide them towards their future! My first-year teaching was hard, but I loved it and taught math at a middle school in Bordertown for 12 years. (Cecilia, Interview Session 2, November 2021)

Cecilia then got the opportunity to go back to school to get her master's degree when she met her high school teacher, now a professor at Bordertown University.

> I had a great opportunity to teach mathematics during a summer camp for elementary level girls at Bordertown University who had a partnership with Southwest University and would give me credit for my first master's class. I loved working with girls and making them feel empowered because they were learning Algebra at such an early age. I remember the feeling of accomplishment because I remembered being a student in the TEX Prep Program in the summer and learning cool math stuff. I also mentored some pre-service teachers through Bordertown University. I then continued taking classes and obtained my master's degree in math and science in 2007 and was able to work as an adjunct professor at Bordertown University. At the same time, I was able to take some graduate courses in my field of interest which was technology, and I also became a master technology

> teacher. With this I had the opportunity to work with a cohort of teachers and teach them how to apply technology into their lesson planning and into creating interactive lessons. (Cecilia, Interview Session 2, November 2021)

Cecilia felt that even though she did not work in the STEM field she would have wanted to, she still challenged herself and became even more educated so that she could hold a higher position in the education career that she had chosen.

> I was then offered a chance to join a cohort of teachers to pursue an administrative certification. I went back to Bordertown University and took classes to challenge the principal certification exam. I passed it an in 2009, I became a Dean of Instruction and eventually an Assistant Principal. With these new positions, I was able to influence more teachers to love math and science. I would go with them to trainings and offer support when they needed it. But most of all, these positions of power have helped me bring math and science to the forefront, which is very difficult in elementary. (Cecilia, Interview Session 2, November 2021)

The Latinas in this study serve in their current roles with the purpose of instilling the love of math and science to their students. They specifically focus on Latina students to make sure that they are aware of the opportunities there are for them in the STEM fields and to encourage them to pursue their own STEM careers.

The four Latinas shared common life experiences that helped them succeed in their STEM interests. Their parents and family provided early education experiences in math and science. Their race and gender was a source of pride for their families, even though they knew that being a Latina in college would be a challenge. For two of the women legal issues and resistance helped them become more resilient. The women learned to trust others' guidance because they were first

generation Latinas whose family couldn't help them because they had limited knowledge about higher education, not because they lacked the *ganas or sueños* for them. Stevenson et al. (2019) emphasize that "students' cultural, linguistic, and experiential background can contribute to the development and enactment of resiliency and, in turn, academic achievement" (p. 4). Although all four Latinas earned a degree in a STEM field and even though they did not obtain a career in their chosen field, these women found a purpose in education: to be the best educator and a positive role model for future Latina STEM degree holders.

Chapter Summary

This chapter highlighted the data obtained through the life histories of four first-generation Latina STEM degree holders. There were important findings that derived from the interviews and the data analysis presented in this chapter in order to understand the relevance of the data which revealed the purpose and overview of the research process. The first finding was the parents developing the Latina's STEM identity from a young age and having expectations of them to attend college. The second finding was that Latinas were motivated by challenge and this challenge was multi-faceted. The third finding was that these Latinas' STEM degree gave them a position of privilege, helped them obtained a position of privilege, but it also served as a way that marginalized them. And a final finding was that for all participants in this study, teaching a discipline in STEM education was a complicated choice but not always a first choice. The next chapter discusses the significance of my study and implications.

CHAPTER V

SIGNIFICANCE AND IMPLICATIONS

This life history case study explored the lived and educational experiences of four first-generation Latinas who navigated the educational pipeline, successfully earning college degrees in STEM majors within fields with a history of low female and racial/ethnic minority representation. In Chapter 4, I discussed the themes that emerged after analysis of the participants' data. This chapter discusses the significance of the findings in relation to the insight they lent into my research questions and discussed the significance and implications of the findings as a whole. In what follows, I lay out the implications of my study in various areas. I conclude the chapter with suggestions for future research.

The life history approach was used to discover what lived experiences have led Latinas in a Bordertown University to pursue a career in the STEM fields. The findings lent further insight into Latinas' STEM journeys that helped us contextualize the experience of being underrepresented in STEM programs across the country, despite a growing Latinx demographic and how participants also used different types of capital to obtain a degree in a STEM field. The findings also emphasized the resilience these Latinas built as they adapted to a new career in STEM education rather than to STEM fields to which they originally aspired. This chapter also discussed curricular implications central to a critical need for increasing diversity, specifically Latinas entering the STEM programs in the United States.

Towards these ends, this study investigated two broad questions and sought insight as to what lived experiences have led Latinas in a South Texas Bordertown to pursue a career in the STEM fields? and what are they doing in their fields to pay it forward and encourage female students to pursue a career in STEM? The following discussion synthesized the findings discussed in chapter four and related them to these questions to highlight key insights.

Participants revealed an affinity for a STEM identity from early on as students which was shaped and reinforced by their parents throughout their STEM journey. One participant wanted to be a chemist, another a veterinarian, another a computer programmer and only one participant got to be an engineer in a short-lived career. However, their fate led them down a different journey, that of an educator. A passion for their chosen STEM field, inspired them to teach their students to learn more and develop a liking to various STEM fields. They also motivated their students, especially Latinas, to pursue a STEM degree as well. These journeys were hard to pin down. Themes within interviews and across data sources intersected and departed in ways that were sometimes difficult to capture. However, as discussed in Chapter 4, I followed themed paths of meaning that led me to four main findings:

1) Latinas were helped by their parents to develop their STEM identity and were expected to go to college

2) Latinas were motivated by challenge and that challenge was multi-faceted

3) Latinas' STEM degree gave them a position of privilege but it also served as way that marginalized them.

4) Teaching in STEM education was a complicated choice but not always a first choice

Research Questions, Lived Experiences and Connections

It has been said that "life is what happens to you while you're busy making other plans" (Lennon, 1980). This statement "reminds individuals that, despite their best efforts at planning, their lives unfold in sometimes unexpected and unpredictable ways" (Bussolari et al., 2009, p. 98). While I was taking doctoral classes and was looking for a topic for my dissertation, I came upon the book "Getting There *Cuando No Hay Camino* (When There Is No Path): Paths to Discovery *Testimonios* by Chicanas in STEM." I was intrigued by all of the women and their stories of success in STEM fields. I then decided to do my own study to include Latinas in our Bordertown school district and their stories about their STEM journeys. I wanted to know more about their lived experiences and how they differed from my own. Thus my research questions emerged.

The first research question was: what lived experiences have led Latinas in a Bordertown pursue a career in the STEM fields?

Latinas' parents helped develop their STEM identity and expected them to go to college

This study found that parental involvement was a key aspect of each Latina's ability to prosper and thrive in school. Most of the participants in this study mentioned that parental support was one of the most important factors in their academic success. The Christina's, Jacqueline's, Regina's and Cecilia's parents had high expectations for their child's education and promoted their child's academic achievement. Christina's parents provided an educational environment at home through access to educational resources like encyclopedias, educational programming on the television and expectations of productive assignments like book reports and science projects after school and during the summer. They valued education so much that they saved up and took Christina to her female cousin's graduation from Stanford University and constantly told Christina that she could graduate from college as well. Regina's parents worked hard to send her to private

school so that she and her sister could obtain a quality education. Regina's mom had high expectations from her and wanted her to become a doctor. Regina was intrinsically motivated and loved learning, especially about life science. She noted that her parents did not have to push her, she knew that she must attend college just like her affluent classmates. Jacqueline's parents also made it a point to send her and her siblings to private school in Mexico where she learned to speak English and insisted that she go to a STEM private school. All participants developed a strong STEM identity as a result of their lived experiences with their parents which encouraged them to seek STEM opportunities in school and outside of school. This identity helped guide their journey towards their respective interests in STEM.

Without knowing, Christina's mother nurtured her thirst for science knowledge through assigning book reports and helping with science projects. Regina's dad took her to her uncle's farm where she learned how to care for animals and learned about many different medicines and treatments at an early age. Jacqueline's dad inspired her to become an engineer through helping him at his auto shop and making measurements of various car parts which facilitated drawing diagrams for her engineering classes. Cecilia's dad asked for help measuring when he was fixing things around the house. She learned about the use of fractions in the real world when she helped her dad get a certain wrench, ratchet, or nut socket when he was trying to fix his truck. These ordinary interactions with our family helped us become comfortable with measurements or scientific terms and develop a STEM identity as young children.

Although the parents had some educational attainment themselves, they used their cultural capital and funds of knowledge to help their child attain high academic outcomes. Parents used aspirational capital by holding onto the hope of their children making a better life for themselves even though there was structured inequality in schools and in the workforce. They used their

linguistic capital through the use of storytelling and in the form of advice or *consejos* that inspired these Latinas to do their best in school because it would lead to obtaining the knowledge and skills to obtain a good career. The parents did not know how to navigate the school system, but they emphasized that education was very important because they acknowledged that life can be hard socially or economically as they found through their own lived experiences. The Latinas parents often told their children that they were capable of being good at school and set high expectations for their academic success. These women's discussion of their background and its assets challenge the deficit models of education propelled in part by the powerfully destructive myth that minority cultures do not value education. Instead, in discussing their backgrounds, the Latinas in my study highlight the role their parents played in the development of their educational goals and aspirations. They pay it forward by being positive role models and even playing the role of parents to students who live with guardians as their parents live in Mexico or to those who live with their grandparents because their parents are unable to take care of them at this time. These findings are consistent with researchers such as Yosso (2005) who stated the "notion of familial capital" sheds light on how Latinas in this study drew on their families as resources for achieving educational goals. Yosso (2015) noted that Latinx youth "learn life lessons on caring and resilience, which help them to develop emotional, moral, educational, and occupational consciousness" (p. 79). Furthermore, Latinas in my study viewed their success not only as an individual accomplishment, but as a collective accomplishment which involved their families. Perez Huber et al. (2018) noted that immigrant families refer to college degrees as *papelitos* which symbolizes hard work and making it in the United States. These parents live their dreams through their children and attaining college degrees becomes a "generational accomplishment".

The Latinas in this study used their funds of knowledge obtained through their lived

curriculum to succeed and obtain a degree in a male-dominated STEM field. This action concurred with a study by Delgado Bernal (2002) which explored the knowledge that Chicana/Chicano students bring from home to help them cope with the challenges that can hinder their academic achievement and readiness for college. Much like findings discussed in Delgado Bernal (2002), my study's findings show how participants "used their bilingualism, biculturalism, and their strong sense of community as resources to grow academically and socially, yet were often still marginalized in STEM fields" (p. 113). Yosso (2005) described this cultural knowledge as "currency" or a lens through which students connected their social identities with their "identities as scientists". While Herrera et al., (2012) found that cultural knowledge can work to legitimize communities of color contributions to science, the STEM journeys of participants in my study demonstrate that this was not always the case for them. But findings from this study also indicated that through their role as STEM educators, teachers could work to incorporate and acknowledge the STEM knowledge of communities of color. As Herrera et al., (2012) wrote "such a search for recognition does not occur with the intention of conforming to the status quo of science or what it means to be a scientist; rather, the desire to succeed is framed in terms of creating new definitions of who a scientist can be and what doing STEM looks like" (Herrera et al., 2012; Tan and Barton, 2008). Similarly, the STEM journeys of participants in this study reveal, in part, Latinas struggling with such definitions. Yet data also showed Latina STEM educators devoted to changing definitions of what doing STEM might look like.

Rodriguez et. al (2017) wrote that "the ability to recognize oneself as a STEM-inclined individual and feel recognized by others enhances a student's ability to persist within the discipline and transition into a related career" (p.2). Similarly, the findings from my study illustrated Latinas' parents working to nurturing STEM identity--sometimes in ways that seemed to conflict with their

own aspirations for their daughters.

I found it interesting that each Latina felt a sense of belonging in their respective field when as they made their journey through the STEM pipeline, even though some teachers, professors or male classmates did not feel that they belonged there. I believe this helped us to persist and obtain a STEM degree because we were just as knowledgeable and enjoyed the discipline just as much as our male counterparts. This persistence resonated with the notions of "aspirational capital" and "invisible strategies" in the context of STEM education from Archer et al.'s framework (2015) which coincided with Johnson et al.'s (2011) term *la facultad,* in which successful women of color could see through their interactions with others, whether they were recognized as legitimate STEM practitioners. Accordingly, "each incident of *not* being recognized as real scientists actually provided an *opportunity*- instead of a seemingly insurmountable obstacle- for further STEM identity development. The extent to which successful women of color in STEM were able to apply *la facultad* empowered them to develop even more fully as who they recognized themselves to be: legitimate scientists engaging in work important to the them and for the benefit of others" (Johnson et al., 2011, p. 339).

Each Latina in this study faced a number of challenges, but instead of hindering their education, they used these challenges to motivate them into becoming a STEM degree holder. Reinking and Martin (2017) noted that girls and boys are socialized differently in the United States. This difference is generally based on pre-conceived ideas of gender roles. Gender roles are defined as sets of "behaviors, attitudes, and personality characteristics expected and encouraged of a person based on his or her sex. What has been found is that, boys are raised to conform to the male gender role, and girls are raised to conform to the female gender role" (p.149). These gender roles that were contrary to the participants' perspectives but also became motivators for these Latinas to

continue their STEM journey. Christina often took the lead in performing dissections, when other girls questioned why she was doing that if she was a girl, stating "that's so gross." Regina's dad wanted a son, but had two daughters instead. He wanted them to be hunters, but Regina's love of animals made her interested in life science, specifically biology so that she could care for them instead of shoot them. Jacqueline was asked several times to go find her class when she first entered her engineering room. She looked around and stated, "no, I am in the right class. I'm staying". Cecilia was fascinated with building bridges and circuits in a summer camp, even though there were more boys, than girls. Cecilia contemplated, "Maybe I want to be an electrical engineer". These types of lived experiences encouraged these Latinas to continue on their STEM journey and take coursework that would prepare them for college.

Once they decided to continue their STEM journeys at the college level, the Latinas in this study used their financial worries to motivate them to do well in school as opposed to letting them be a deterrent in their educational quest. They used this stress and worry as an incentive to succeed in school because they understood that education was an important factor in climbing the economic ladder and increasing their economic mobility. These Latinas were also very resourceful when it came to searching for various forms of financial aid to help them pay for their college education. They went to counselors, talked to teachers or faculty, and went to various community resources to seek out college funds. Many students do not know about many resources out there and think that college is unattainable. Hinojosa, Rapaport, Jaciw, and Zacamy (2016) noted that Hispanic students have fewer resources and less qualified teachers in schools with greater numbers of minority students, lower expectations, and less representation in higher-level classes. However, the Latinas in this study were proactive and found valuable resources that would enable them to continue on their last leg of their STEM journey as a student. Socioeconomic status has a strong

correlation with college access and lack of financial resources can leave Latinas with a sense of hopelessness when it comes to gaining access to higher education. These Latinas, however, took action against the economic forces that could have hindered their college aspirations,

Hill et al. (2010) noted that "the foundation for a STEM career is laid early in life, but scientists and engineers are made in colleges and universities" (p. xv). Likewise, findings in my study indicated the way solid academic foundation supported STEM career aspirations, put them in the STEM pipeline, but that ultimately the STEM field pipeline was a leaky one. Jacqueline and Cecilia had some language barriers that they overcame to be able to enroll in advanced placement classes which set them on the correct pathway to pursuing a STEM degree in college. Crisp and Nora (2012) stressed the importance of ensuring that Hispanic students participate in advanced placement courses in STEM-related subjects prior to college:

> Among Latina/o and other minority groups, the likelihood of persisting in a STEM major has been shown to be strongly related to various pre-college experiences and behaviors … as well as the number of advanced placement courses taken in STEM fields prior to college. (p. 7)

Three of the four participants in my study were determined to be placed in honors or AP classes, and their persistence, in part, paid off. The fourth participant followed a similar path but in her home country of Mexico. Teachers or counselors noticed the Latinas' grades and academic potential and were placed in higher level classes which gave them access to a more rigorous curriculum. This placement helped them get prepared for future college aspirations, yet did not necessarily help them achieve their initial career aspirations.. Having access to more rigorous curriculum led to higher competitiveness among peers and ostensibly set the stage for achievement in a higher-ed STEM curriculum that values competitiveness. Interview data show this sort of

rigor as fostering a college-inspired attitude among the Latinas. The Latinas in my study were conscious of their worth as students and knew they deserved the best from their schools and their teachers.

The Latinas that participated in this study were successful in their educational journey, albeit arguably less successful in their STEM sector career journeys, because they were well-prepared for college and STEM-related coursework. But, it is worrisome for those Latinas who do not know how to navigate the education system, and they essentially lose out on reaching their full educational potential. It is also worrisome, that despite these educational gains, the STEM sector career journeys of these bright and ambitious future scientists were still re-routed to the educational sector. On one hand, this detour to the teaching profession can be seen as a hegemonic tilt toward the status quo. But participants in this study also illustrated the ways in which the teaching profession allowed them to pay it forward and redefined their new role as STEM mentors.

Participants in my study agreed that sexism in the STEM fields was more prevalent than racism, both academically and professionally. Interview data illustrated that Latinas experienced a culture that made them feel excluded in the STEM fields. The participants noted that negative stereotypes still exist even though the number of women in STEM fields is growing. Cheryan, Master, and Melzoff (2015) stated that researchers began to look at the lack of women in STEM fields. They found that "students' stereotypes about the culture of these fields- including the kind of people, the work involved, and the values of the field- steer girls away from choosing to enter them" (p. 49).

Gilbert and Calvert (2003) stated that most gender and science education research begins with the problem of young women unwilling to choose science and results in a call for a change. This problem with gender and science was that science is viewed as a "masculine pursuit."

Kulturel-Konak, D'Allegro, and Dickinson (2011) agreed with this view and stated that although objectivity and rationalism are important, they did not accommodate to women (p. 9). These characteristics are very important in STEM, however "interpersonal skills, such as listening, empathy, and sensitivity, facilitate success in the workplace" (Joshi and Kuhn, 2005 in Kulturel-Konak, D'Allegro, Dickinson, 2011, p. 9). These Latinas may be viewed as outliers and provided counter stories to the myth that women are not good in math or science. They rose up to the challenge of enrolling in STEM courses in high school and then at the university. Their strong sense of belonging and STEM identity made them feel empowered as they navigated through a leaky STEM pipeline. A pipeline that, for participants in this study, prepared them for a STEM sector career but ultimately led to educational sector jobs. Yet, findings from this study also showed the ways in which Latina educators conceptualized STEM education as a place for them to help a new generation of Latina, future scientists to fix the leaks in the STEM pipeline while disrupting it.

I draw upon Maxwell and Roofe (2020) to describe my newfound understanding of the student-teacher relationship:

> *Currere* is one way of aiding teachers to re-attune, as it opens one up to reflection and self-critique and, hence, to making change. Through *currere* teachers can better see and understand who it is that they are. In this understanding, they may live a curriculum story that will allow them to understand that their students have their own stories. Every institution preparing teachers should introduce them to currere so that the lived curriculum can become fully actualized. The prescribed curriculum is nothing but a framework; true curriculum is lived out by students with their teachers and teachers with their students. (p. 33)

I then used this newfound understanding and the focus on currere as a sort of self-reflection of my participants as students. What did they learn along their STEM journey as students? Which then led to my second research question.

The second research question was: What are these Latinas doing in their STEM education disciplines to pay it forward and encourage female students to pursue a career in STEM fields? Latinas' STEM degree gave them a position of privilege, but it also served as a way that marginalized them.

Cantu (2012) stated that "the 'alien' world of STEM, where most professors and professionals are white, male and middle class, posed an even greater challenge for these brown, working-class Chicanas" (p. 481). Christina found a female role model at Bordertown University who helped her believe in herself while obtaining her degree in chemistry. Jaqueline refused to move when asked by her male professors in her engineering class to double check and see if she was in the correct classroom. Regina noted that while taking classes at the university, there were more males than females, but she felt confident in her love of biology. She also remembered working part-time with a male veterinarian who treated her condescendingly even though she was asked to do his work for him. Cecilia felt intimidated in a computer programming class that was mostly male, but she refused to give up because she could not see herself doing anything else.

Cantu (2012) stated that "What is extraordinary is that they succeeded despite these challenges. There are well-known, long-standing stigmas imposed on girls and women drawn to STEM fields; for Chicanas, as indeed for most women of color, the barriers are multiplied, a network of interlocking biases" (p. 481). However, Latinas in my study had the support of their families, communities, teachers and role models and were able to overcome class bias and racist/sexist conditions to obtain solid STEM educations that put them in the position to use their

lived experiences to help Latina students along their own STEM journeys..

This experiential knowledge is referred to by Delgado Bernal (2002) as the knowledge Chicana/Chicano college students learned from home and successfully employed when confronted with challenges and obstacles that impeded their academic achievement and college participation. The application of this household knowledge interrupted transmission of "official knowledge" and helped students navigate around educational obstacles.

The participants in Delgado Bernal's (2002) study are very similar to the participants in my study. They "voiced a strong commitment to their families or the Mexican communities from which they came, a commitment that translated into a desire to give back and help others" (p. 114). The Latinas in my study paralleled Villalpando's (1997) national research which found that "that in comparison to White students, Chicana/Chicano students enter college with higher levels of altruism, stronger interests in pursuing careers serving their communities, and stronger interests in helping their communities" (Sanchez, 2020, p. 53). These Chicana/Chicano students were committed to be a source of inspiration and motivation to their students to overcome educational obstacles.

Likewise, the Latinas in my study have successfully navigated the STEM education pipeline and have obtained a degree in a STEM field. They have the experience that it takes to teach the next generation of Latina scientists, mathematicians, engineers, or computer scientists. This experience gives them a new sense of purpose. They cannot lose their passion for the STEM field they chose to pursue and are paying it forward by motivating future Latinas to engage in STEM activities from the elementary level all the way to high school. Two of the four Latinas in this study are now administrators trying to make teachers aware of the importance of teaching math and science in a way that is relatable to their students and to make it easy and fun for them

to learn, especially in our STEM-focused campus.

Teaching in STEM education was a complicated choice but not always a first choice

The Latinas in my study successfully navigated through the STEM pipeline in order to obtain their STEM degree in their area of interest. However, when they graduated and it was time to embark on their exciting STEM career, there was a plot twist in their life stories. The exit from STEM coursework or preparation for the workforce is called the "leaky pipeline" because "there is a disconnect between what the parents, teachers, and students believe that the female students can do and what the hiring managers on the other side of the educational system believe the females graduates can do. The teachers and parents encourage girls to do and be whatever they want, but when they graduate from STEM university degrees, female graduates get fewer jobs than their male counterparts" (Filippi and Agarwal, 2017, p. 260). This point was where the pipeline became leaky because even though they graduated from a STEM field of study, they cannot find support or employment. Blickenstaff (2005) emphasized the following dilemma "the pipeline provides female graduates, but hiring managers' and supervisors' misconceptions about their abilities because of their gender have stemmed the flow of women into STEM fields. These biases and misconceptions can include marital bias, or bias against women who may have children, among other things" (p. 369).

Gallard et al. (2019) noted that "on a daily basis, these Latinas struggle to maintain a sense of balance between their professional aspirations in the STEM fields and the multiple sociocultural, -economical, -historical and -political contexts within which their lives enacted" (p. 1081). The Latinas used these Contextual Mitigating Factors to position and reposition themselves within social places. When these researchers were perplexed as to why few Latinas experienced success through the STEM pipeline, they noticed that the Latinas' "individual experiences,

including overcoming adversity, assisted them in creating filters, such as resiliency, to make sense of their worlds both in and out of school" (p. 1082).

The Latinas in my study reacted to the adverse situation of not being able to find a job they worked so hard for with resiliency. The participants knew that they were being positioned in a difficult place and developed tactical understanding to overcome their limit-situations. This positioning was further discussed by Freire (2014) as he noted:

> As they separate themselves from the world, which they objectify, as they separate themselves from their own activity, as they locate the seat of their decisions in themselves and their relations with the world and others, people overcome the situations which limit them: the "limit-situations". Once perceived by individuals as fetters, as obstacles to their liberation, these situations stand out in relief from the background, revealing their true nature as concrete historical dimensions of a given reality. (p.99)

Christina recounted how she went to an interview with a panel of men for a job that would enable her to use the knowledge and skills gained through her STEM degree in chemistry, but they did not contact her until after she had accepted a job with the Bordertown school district. Christina was intimidated by the notion that she would be working in a male-dominated work environment and accepted a job where they value women, especially women with STEM degrees. Jacqueline actually worked as an engineer in her home country of Mexico and used CMFs to work with men at a maquiladora. She was only one of two female engineers hired at the plant. However, when Jacqueline got pregnant, she decided to move to the United States to look for a better life. She used her sense of resiliency to start all over again in a totally different career. Regina obtained her degree in biology and was even accepted to medical school, but since she had worked with men in

the veterinary field, she was dissuaded from pursuing a higher degree in a medical field due to the condescending manner in which she was treated. Regina also used CMFs to reposition herself in a totally different career field. And finally Cecilia was excited to embark on a new career where she could apply the technology skills that she acquired through her STEM degree, but was discouraged when the men that interviewed her wanted someone with more experience or other sets of skills. Cecilia also used her resiliency to transfer to a different career field. All of my participants overcame the "limit-situations" that they saw themselves in. Gallard et al. (2019) emphasized that "while successful Latinas have stood at the crossroads of entering into STEM fields, in spite of their successes, the pattern in the field continues to be a world which is still significantly dominated by their male counterparts, especially white men" (Reigle-Crumb and King, 2010) (p. 1084). In a sense, the participants were liberated from working in places with "chilly climates" where they would be constantly trying to prove that they belonged.

Throughout modern history, education has consisted of students passively sitting in classrooms, listening to teachers, reading books, taking notes, completing assignments and testing for content which usually involved memorization. Many students do not thrive in this educational environment. They see no meaning in what they are learning: a set of unrelated tasks. A recent reform in school education has emerged in which instruction is now student-centered and the teacher acts as a facilitator. It is surprising that this reform is not new and has in fact been recommended before. The Latinas in my study have first-hand experience about what it takes to develop a strong STEM identity and are now striving to instill their love of STEM and transfer their skill sets to their Latina/o students.

I read an article about how every teacher is different. It is through their lived experiences that a teacher learns how to teach. In doing so, each teacher has a unique teacher's thumbprint

> which contains, among other things, the knowledge of how a student learns best. It encompasses much more than just knowing what a child likes to do outside of school, it's knowing how a student's personality influences how they learn. It's understanding which students are comfortable speaking their thoughts and which prefer to write them down. All of this starts with teachers knowing what students know. A teacher's thumb print isn't just the *knowledge,* it's what you DO with the knowledge. (Francis, 2020)

These Latinas' thumbprints are formed through heritage, language, and culture. They know the value of their culture and language and use culturally relevant pedagogy because they know that "when academic skills and knowledge are situated within the experiences and frames of reference of students, they are more personally meaningful, have higher interest appeal, and are learned more easily and thoroughly" (Gay, 2002). Christina uses her sense of curiosity and love of science to teach students about life science through the use of a university camera viewing an owl going about its daily business. Students learn about different types of owls, food webs, and she incorporates science into her daily reading activities. Therefore, her students learn science because it is fun and they experience it first-hand. She also recruits Latinas to come and join her after-school Robotics club so that they can learn about building robots and coding. Milford and Tippett (2015) emphasized that "science instruction at this level should address what children know and what they can learn, involve and inquiry approach, and provide appropriate scaffolding to foster conceptual understanding and reasoning" (p. 25). Furthermore, the National Science Teachers Association (2014) in Milford and Tippett (2015) provided a statement which "focuses on children's predisposition to observe, explore, and discover the world they are surrounded by and affirms that learning science and engineering practices foster enjoyment, curiosity, and lay the

foundation for the progression of science learning through their entire lives" (p. 25).

Jacqueline uses what she learned as an engineer in Mexico to implement Project Lead The Way lessons about aerospace engineering and testing materials to improve their design. Her students love to be in her lab learning through trial and error but always learning why something didn't work so that they can improve it for the next test run. By doing this, Jacqueline is using an approach of STEM "which is to use science, math, and technology as tools to actively engineer something, with the engineering processes being the focus of the project. Students perform research, work with their community, and design a solution. The solution would then be created or manufactured, tested, and compiled into a final product" (Kasza et al., 2017, p. 53).

Regina was proud when she became a teacher and opened a new science lab and taught science lessons to her elementary students through hands-on experiments. The students were excited when they were scheduled to have fun in her lab. Regina loved to teach science to her students, especially the part that dealt with life science, since it has always been her passion. She now is a mentor for teachers and helps them integrate math and science lessons into their daily curriculum. When Cecilia was a math teacher, she taught her middle school students to not be afraid of math and to learn to love it. She made the math lessons as easy as she could so that they could learn hard concepts like solving algebraic equations which would help them in high school. Often times, she would have to translate the lesson for her ESL students. She coached a team of girls for a number sense competition and won 1st place, teaching them that girls are mathematicians too. Cecilia now uses her love of technology to help teachers in her campus teach interactive math and science lessons through iPads and Clear Touch Panels. She also helps teachers use technology to help their bilingual students practice their English through interactive lessons, by recording themselves and then listening to their video recordings.

Another notable finding in regard to academic preparation was the fact that each of the four participants identified valuable role models and effective teachers as major contributors to their college aspirations. These Latinas viewed well prepared and engaged teachers as resources to advance their education. Filippi and Agarwal (2017) stated that "using examples of successful females in STEM, girls are more likely to enter STEM careers and overcome challenges. Furthermore, telling women that STEM fields are becoming more diverse make them more likely to persist when they meet personal and professional challenges" (p. 260). High quality instruction and high expectations helped these Latinas navigate the STEM education pipeline. The number of years of teaching or educational attainment of the teachers did not matter as much as the fact that the teachers cared about their students. Three of the four Latinas in this study felt that a teacher's nurturing and positive affirmations towards them made them effective teachers. These Latinas' life stories highlighted a special teacher who served as a role model for their new roles as teachers. The teachers made the students interested in a STEM discipline, made them feel competent, and encouraged the students' belief in themselves. Hill et al. (2010) stated "one finding shows that when teachers and parents tell girls that their intelligence can expand with experience and learning, girls do better on math tests and are more likely to say they want to continue to study math in the future. By creating a "growth mindset" environment, teachers and parents can encourage girls' achievement and interest in math and science" (p. xiv).

An unexpected outcome that came from these Latinas having role models and then being role models themselves was that while they were teaching their students to love science, technology, engineering and math, they were learning alongside their students and empowering themselves as STEM facilitators. Masarik (2015) stated that while she was a program specialist and camp director for Girl Scouts and designed programs that exposed girls to science, she got

enthusiastic about the STEM experiences that are abundant in everyday life. She noted that:

> to successfully facilitate STEM learning, educators need to learn the content, and more importantly the methods that increase learners interest and excitement. As educators work to increase their skills and knowledge to present the best experience for their students, an unexpected outcome can be an increase in their own self-efficacy and STEM identity. (p. 36)

As they were growing up, the Latinas were developing their STEM identity through daily interactions with their parents and teachers. Now as teachers, and role models themselves, they are re-edifying their sense of self-efficacy and STEM identity even though they are not part of the STEM workforce.

Implications for Educational Practice

This study provides insights into the ways which practice and research can become more inclusive of first-generation Latinas in STEM fields. Four Latinas provided insights about their STEM educational journeys and identified strategies that they used to navigate the STEM educational pipeline successfully. The following are implications for teacher education.

Community and cultural wealth are extremely important when implementing them into teaching practice. When answering the question, why are there so few women in science, technology, engineering, and mathematics, Hill et al. (2010) stated that the answer lies in our perceptions and beliefs about gender in math and science. Traditional gender roles for women in Latino families often discourage Latinas from pursuing STEM careers. However, the Latinas in this study noted that their strong family support system as well as the high expectations held of them helped them achieve their success.

Researchers have found parental involvement can support children's informal STEM

activities in after-school programs. (Hill and Tyson, 2009; McWayne et al., 2004). This support encourages students to find additional opportunities to explore STEM topics. One intervention "showed a significant effect on high school STEM preparation and predicted subsequent STEM career pursuit" (Rozek, Svoboda, Harckwiewica, Hilleman, and Hyde, 2016). "Successful implementation of this strategy required parental knowledge of relevant school and community resources and STEM career and college pathway" (Thomas et al., 2020, p. 7). Many students' parents do not know about the importance of STEM and how taking these courses can give their children the leverage they need to engage in rigorous curriculum that will better prepare them for their future careers. Many of the participants in this study noted that their parents did not know about STEM. Many of the participants in this study noted that their parents did not know about STEM, but they used their problem-solving and navigational skills to enroll in STEM courses and obtained a bachelor's degree in STEM, despite this setback. This finding is contrary to the abundant research that calls for schools to educate parents about STEM opportunities.

As seen in this study, Latinas faced various challenges and these challenges were multifaceted. A student's socio-economic circumstances can help or hinder his or her advancement in academic achievement and build a positive attitude towards STEM subject areas. Those with a higher socio-economic status have a greater chance of obtaining better opportunities to choose a STEM field as a college major and career pursuit. Educators can help girls see that their success in high school not just as a requirement to enter college but also as a key to success in various science, mathematics and engineering careers. This outlook can help them with mobility in their socio-economic status. At the middle school level, educators can encourage more Latinas/os to take higher-level math and science courses which will open career doors for them. This would also prepare them for rigorous college coursework. The Latinas in this study overcame

various obstacles and challenges. An implication for practice would be to give Latinas challenges and provide support to help them become critical thinkers and problem solvers to overcome them or find a solution.

Nation et. al. (2019) emphasize that despite gains in educational achievement, "women and individuals from nondominant cultures remain underrepresented in STEM majors and careers" (37). They state that after-school programs can offer a great context for engaging diverse students. The authors discussed the STEMinist program which involved only girls ages 9-11 who read about young scientists and participated in hands-on science and engineering activities in labs at a close-by university. Through this program, the students learned integrating disciplines of practice, presenting science as pushing through difficulty, positioning participants as being and becoming scientists, engaging participants in shared experiences. Three of the four Latinas in my study indicated participating in a similar after-school or STEM summer program. These types of programs expose Latinas to STEM professionals and what they do. This exposure can inform and encourage them to become STEM professionals themselves. Therefore, educators can inform and inspire more Latina/o participation in these programs. Bridge programs can create valuable networking as students are transitioning from elementary to middle school and from middle school to high school. After-school programs provide students with opportunities to engage in STEM activities without the worry about getting a grade or having the fear of failure. These programs can also help students overcome language barriers by engaging students in communicating with each other using STEM vocabulary, which will help them gain more confidence in speaking and presenting their ideas to others. When Latinas are ready to graduate from high school, universities could develop educational programs that will help them obtain internships or find jobs in STEM fields.

Cordero et al. (2021) emphasized the need for "fostering a positive environment in this field from a young age will allow students to develop their STEM identity early and will provide them with the needed support to start and finish a STEM degree" (p. 48). Many of the participants in this study related to having experienced some sort of racism or sexism as they were navigating the STEM educational pipeline. Therefore as a community, we can help spread the word about girls' and women's achievements, especially in the STEM disciplines. Educators can help eliminate the stereotypes by presenting girls and boys to female role models in STEM careers or talking about the greater numbers of girls and women who are high achievers in STEM courses and fields. Latina educators can serve as positive role models and engage students in after-school or summer bridge programs, which can motivate Latina students to join and hopefully spark a STEM interest in them. At the university level, institutions can focus on creating a positive sense of belonging in STEM spaces rather than continuing to perpetuate the "chilly climate" that many underrepresented minorities experience. Universities can create a cohort of STEM first-generation, underrepresented college students that can serve as mentors to support incoming Latina/os on their higher educational STEM journey. Universities can also have advocates available to help Latina/os challenge bias and unfair treatment in STEM courses. The findings of this study call for a positive change that can empower Latinas to feel more confident about increasing female representation in STEM careers.

Future Research

This qualitative life history case study provided insight into the type of future research that may be done to further understand the experiences of first-generation Latinas as they navigate the STEM pipeline and successfully obtain a degree in a STEM education field. Studies could be conducted to include more life stories about Latinas who have successfully navigated the STEM

fields and investigations about how these Latinas are contributing to the science, technology, engineering and mathematics fields and whether some of them have transitioned into the educational field.

For future research, I could revisit these Latina STEM educators and have a focus group with the students that they mentored and found success in STEM fields. Another research that would be a good follow up to my study would be exploring internships of Latina/os from our university. How do they experience the transition from the STEM educational pipeline to the STEM workforce? Is it easier to obtain these on-the job trainings now than it was for the Latinas in my study?

Additionally, it is very important in future research that we look for successful Latinas in the STEM workforce who have transitioned to teaching at the university level. These Latinas have successfully obtained a degree in a STEM field and were able to transition into the STEM workforce. What experiences helped them make this transition easier for them? How did these Latinas address challenges while working within STEM fields? Did they experience microaggressions in the workforce and how did they deal with them? This research can help us learn how these Latinas were able to make the transition into the STEM workforce and maybe give us insight as to what can be done to increase Latina/o representation in the STEM workforce in our little niche or corner of the world.

A Call to Action

Catsambis (1994) emphasized that there was a lack of research focusing on women's experience in mathematics. She noted "women of color are the most underrepresented group in mathematics and science but few researchers have specifically studied their educational experiences" (p. 201). Varley-Gutierrez (2009) also noted that there are similar gaps in the

literature and states that "little (if any) mathematics education research speaks specifically to girls of color or to a feminist of color" and that there is "an urgency to include the voices of women of color in re-envisioning Mathematics education [so that it can be] used as a tool to transform society to be more just" (p. 49). Rodriguez et al. (2017) concurred and stated that "this is seen in the substantial focus on women in science and student of color in science; however, an understanding of the experiences of women of color in science is only just beginning to develop" (p. 233). The number of Latinas/os in U.S. schools is growing, but Latinas are still underrepresented in STEM, and this failure calls for immediate attention. This urgency highlights the need for educational excellence in science, technology, engineering and math fields and the often underestimated and overlooked pool of Latinas who can bring a new perspective, and diverse ideas to the forefront. My study intends to fill this gap in the literature by providing the voices of Latinas and how they used various strategies to overcome challenges in their STEM journey and how they, as STEM educators are now using lessons learned from their lived experiences to make their students aware of the value of knowledge of STEM fields, how it relates to them and the world around them, and how it can offer them a pathway to financial freedom. They are using education as a tool to transform society one student at a time.

The results from this study will be a scholarly contribution that will further the dialogue about Latinas in STEM and highlight the additive, not subtractive, view of their educational experiences. The most difficult obstacles that these women encountered while navigating the STEM pipeline can be used to discuss new policies and procedures that educational institutions can incorporate into their STEM programs to make these students more successful. At the time of this study, a need exists for more qualitative scholarly work critically examining Latina's experiences in STEM while focusing on the intersectionality of race, class, and gender bias that has made these women's

educational journey so difficult, yet at the same time inspiring.

"May we do work that matters. Vale la pena"

Gloria Anzaldua

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APPENDIX

APPENDIX

Interview Protocol Form

Study: Latina women in STEM education: Paying it Forward

Date: _____

Time: _____

Location: _____

Interviewer: _____

Interviewee: _____

Informed Consent Form signed? _____

Notes to interviewee:

Thank you for your participation. I believe your input will be valuable to this research and in helping grow all of our professional practice.

Confidentiality of responses is guaranteed.

Approximate length of interview: 90 minutes, four major questions

Purpose of research:
The purpose of this life history study is to critically explore the lived experiences of a group of Latinas through their STEM journeys to obtain a bachelor's or master's degree and are now successful professionals in different STEM education fields, particularly in science, math, and engineering. This study also aims to recreate these lived experiences to motivate and encourage the next generation of Latina students to become STEM degree holders and enter into the STEM workforce. Each participant's context and perspective is unique to their lived experiences, therefore, this study sought to identify:

I. What are the cultural issues and gendered expectations these first-generation Latinas encountered through their lived experiences as children, as students in the K-12 setting, and then at the college/university level?

II. Who influenced, supported or mentored these Latinas? What challenges and obstacles did these Latinas face as they navigated through the STEM pipeline?
III. What strategies did these Latinas utilize to help them develop resilience in their quest for success in obtaining a degree in their chosen STEM field?

Methods of disseminating results: Data Analysis and Findings section of this dissertation.

Interview Prompts:

1. For our first interview session, I ask that you choose 3-5 artifacts (they can be pictures, video clips, letters, or books) that remind you of pivotal instances in your STEM journey as student.

   What artifacts did you choose?

   Why did you choose these specific artifacts?

   Do these artifacts take you back in time to a specific period where you felt encouraged or discouraged to embark on your STEM journey as a student?

   Was there a specific time in history that coincide with these experiences or events?

   Response from Interviewee:

   Reflection by Interviewer:

2. For our second interview session, I ask that you choose 3-5 artifacts (they can be pictures, video clips, letters, or books) that remind you of pivotal instances in your STEM journey as student.

   What artifacts did you choose?

   Why did you choose these specific artifacts?

   Do these artifacts take you back in time to a specific period where you felt encouraged or discouraged to embark on your STEM journey as a teacher or professional?

   Was there a specific time in history that coincide with these experiences or events?

   Response from Interviewee:

Reflection by Interviewer:

3. For our third interview session, I ask that you choose 3-5 artifacts (they can be pictures, video clips, letters, or books) that remind you of pivotal instances as a lived curriculum, or anything significant outside of school or work, such as your family, church, or any other types of supports that helped you navigate through your STEM journey?

   What artifacts did you choose?

   Why did you choose these specific artifacts?

   Do these artifacts represent important supports that helped increase your determination as you continue to navigate through your STEM journey?

   Was there a specific time in history that coincide with these experiences or events?

   Response from Interviewee:

   Reflection by Interviewer:

4. For our final interview session, we will engage in member check. I will share my transcription of our three interviews with you. I will also share my interpretation of your STEM journey path line.

   Is there anything you wish to change or elaborate on?

   Would you like to delete or restate anything in the transcript?

   Is the STEM journey path line accurate or would you like to change any aspect of it?

   How did engaging in this reflective process about your STEM journey make you feel?

   Response from Interviewee:
   Reflection by Interviewer:

   Closure:
   - Thank interviewee for participation
   - Reassure interviewee of confidentiality
   - Ask permission to follow-up

BIOGRAPHICAL SKETCH

Evangelina Guillen is an administrator at an elementary school. She has been an administrator for 14 years and was a mathematics teacher at the middle school level for 12 years. She obtained a B.S. from Texas A & I Kingsville in December 1995, a M.Ed. in mathematics and science from the University of Texas at Brownsville in August 2007 and is a doctoral candidate in curriculum and instruction with an emphasis on science through the University of Texas Rio Grande Valley. In December 2022, she earned an EdD in Curriculum and Instruction from the University of Texas Rio Grande Valley.Her research interests lie at the intersections of curriculum, STEM disciplines, teaching and learning, and social justice. She currently works at a STEM-focused elementary in Brownsville, Texas. Her personal email address is evaguillen03@gmail.com.