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Las Mujeres in the STEM Pipeline:

How Latina College Students who Persist in STEM Majors

Develop and Sustain their Science Identities

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Las Mujeres in the STEM Pipeline:

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Develop and Sustain their Science Identities

by

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Dissertation

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Dedication

Dedicated to all of the bold, empowered women who have been a part of my life.

You have made my success possible and continue to remind me why I do this work.

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My academic journey would not have been possible without the continued support from those around me. Individuals who have invested in me, presented opportunities for my growth, and provided the experiences and networks I needed to flourish. If this acknowledgements section is long, it is because my work represents the commitment that so many individuals had to my success.

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Las Mujeres in the STEM Pipeline:

How Latina College Students who Persist in STEM Majors

Develop and Sustain their Science Identities

Sarah Lynette Rodriguez, PhD.

The University of Texas at Austin, 2015

Supervisor: Victor B. Saenz

Over the past decade, an extensive amount of scholarship and media attention have been devoted to understanding the unique educational experiences and challenges of STEM students, however, few studies have explored the intersection of race/ethnicity and gender, especially in terms of science identity development. Given the significant growth of the Latina/o community, understanding Latina STEM college experiences, specifically, will be critical to enhancing educational experiences for the Latina/o STEM community. Existing literature suggests that developing a strong science identity during college may improve persistence for women of color in STEM. This research study uses qualitative methods to gain an in-depth understanding of how Latina college students at a public tier-one, predominantly white, research university make develop and meaning of and develop their science identities. The study found that Latinas develop their STEM identities primarily around aspects of building competence, recognition from self and outside sources, and performance of STEM behaviors. Their STEM identity development was influenced in terms of intersectionality, primarily by their gender and racial

identities. This study is uniquely positioned to advance new knowledge regarding Latina students' persistence in STEM fields, which may inform local, state, and federal STEM policies.

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Chapter 1: Introduction

As a result of the heightened demand for a larger and more capable science, technology, engineering, and mathematics (STEM) labor force, policy discussions around the STEM education pipeline have become increasingly prevalent (National Science Board, 2008; National Science Foundation, 2006, 2011). Over the past decade, an extensive amount of scholarship and media attention has been devoted to understanding the unique educational experiences and challenges of STEM students (Hurtado et al., 2010; Museus et al., 2011), however, fewer studies have explored the intersection of race/ethnicity and gender (Carlone & Johnson, 2007; Ong et al., 2011; Riegle-Crumb & King, 2010). A critical component of these policy discussions centers upon the investment of *all* Americans in order to build a stronger STEM workforce. Yet, women of color continue to be represented within U.S. educational and research infrastructures (Ong et al., 2011). As a whole, women of color are underrepresented in the STEM education pipeline and STEM workforce relative to their proportion within the U. S. population, as compared with White and Asian American/Pacific Islander women (National Science Foundation, 2007; U.S. Census Bureau, 2009).

Thus, women of color represent a significant source of untapped talent that could be further cultivated to help advance our economic vitality in the global economy, as well as address the rapid shift towards a majority-minority demographic reality. In sum, preparing young women of color to be active participants and leaders in the STEM fields is essential to securing our future economic and social prosperity, but we must first better understand how to better cultivate this untapped resource.

The STEM academic pathways for Latinas[1] in college are especially important to investigate further. Latinas are entering institutions of higher education at greater rates than ever before, yet they experience lower completion rates and are more underrepresented in STEM careers than their non-Latina/o peers (National Science Foundation, 2003; Santiago, 2008). Although Latinas belong to the second largest racial/ethnic group in the nation (trailing only Caucasians), they continue to earn fewer STEM bachelor (4.33%) or doctoral degrees (2.53%) than all other female groups, except Native American women (Ong et. al, 2011). And, while Latinas make up seven percent of the total female U.S. population ages 15-24, they receive just over four percent of the STEM bachelor's degrees awarded (Ong et. al, 2011).

According to a compiled report of national data from Excelencia in Education (2015), fewer first-year Latinas reported the intent to major in STEM science and engineering fields and Latinas represented a smaller percentage of women earning STEM bachelor degrees and entering science and engineering occupations. In 2012, 37% of Latina freshman at four-year colleges indicated they intended to major in science and engineering fields whereas 48% of their male counterparts indicated the intent to major in these areas (NSF, 2014). Overall, Latinas represented a small percentage of all women who earned bachelor degrees in STEM, with 8% of all women who earned bachelor degrees in STEM being Latina as compared to Whites (61%), Asians (14%), African Americans, (9%), and others (7%) (NCES, 2014). Latinas who did earn bachelor degrees

[1] Latina: A person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin, regardless of race.

in STEM disciplines were concentrated heavily in biological and biomedical sciences (57%) rather than in engineering technologies (2%), mathematics and statistics (7%), or the physical sciences (9%) (NCES, 2014). Finally, Latinas with STEM degrees have lower representation in science and engineering occupations and are less likely to work in these fields even when they have their degree, in comparison to their Latino male counterparts (19% Latinas, 37% Latino males). Extant literature points to strong pre-college science experiences, family and teacher encouragement, self-advocacy and perseverance as critical factors of success for women of color in STEM (Brown, 2002; Russell & Atwater, 2005); however, these studies oversimplify or ignore *how* race, ethnicity, and/or gender create complex identity experiences for women of color, and, more specifically Latinas in STEM disciplines.

A different set of theoretical lenses, such as identity development and intersectionality, are needed in this area to address the dynamic relationship between structure and individual agency, and describe the ways in which those relationships develop over time (Carlone & Johnson, 2007; Crenshaw, 1991). The construct of identity addresses the nature of "individual agency as well as societal structures that constrain individual possibilities" (Brickhouse, 2000, p. 286). In addition, the view that identity is not predetermined or static allows researchers to study an individual's identity across time and in different contexts (Brown, Revels, & Kelly, 2005; Gee, 1999; Lemke, 2001). Further exploration of how science identity relates to the educational experiences of Latinas in STEM is critical to creating a more nuanced understanding of their experiences. This exploration may reveal differences in how Latinas negotiate and

perform their science identities and how Latinas attribute science identity self and external recognition. Encouraging a more in-depth, intersectional approach to science identity development will allow me to understand where those identity intersections lie and how intersectionality affects science identity development for Latinas in STEM. Therefore, the theoretical lens of identity has the ability to help researchers go beyond those critical factors of STEM success to engage Latina STEM achievement as a product of science identity development (Carlone & Johnson, 2007).

Given the economic, policy, and demographic imperatives to produce an educated, diversified STEM workforce and the need for richer theoretical lenses to examine the racial, ethnic, and gender identities of Latinas in STEM, this phenomenological study examined the lived experiences and science identity development of undergraduate Latinas in STEM disciplines utilizing a science identity theoretical framework (Ong, 2011; *Excelencia* in Education, 2015). In addition, the research study will draw from tenets of intersectionality in order to tease out even more nuance in terms of the way that science identity is influenced by race, ethnicity, gender, etc. (Crenshaw, 1991). Chapter 1 provides an overview of the problem, the purpose and significance of the study, and a brief description of the theoretical framework and methodology that will be implemented within the study.

Problem Statement

As the world economy becomes more intellectually and technologically advanced, occupations in the science, technology, engineering, and mathematics (STEM) fields are considered critical to ensure the United State's global competiveness. Technological

innovation accounted for almost half of U.S. economic growth over the past 50 years, and the 30 fastest-growing occupations in the next decade will require at least some background in STEM (U.S. Department of Commerce, 2010). In fact, STEM occupations are projected to grow by 17 percent from 2008 to 2018, compared to 9.8 percent growth for non-STEM occupations (U.S. Department of Commerce, 2010).

American business, educational, and political leaders are concerned about the supply and availability of STEM employees. Voicing the concerns held by many of these stakeholders, President Barack Obama issued this statement, endorsing STEM education during the National Academy of Sciences:

> We know that the progress and prosperity of future generations will depend on what we do now to educate the next generation. Today I'm announcing a renewed commitment to education in mathematics and science…Through this commitment, American students will move –from the middle to the top of the pack in science and math over the next decade – for we know that the nation that out – educates us today will out – compete us tomorrow. (Obama, 2009)

Through his statement, Obama acknowledges that the growth and prosperity of the United States hinges on the ability to educate youth, particularly those in STEM fields. This commitment extends throughout the P-20 educational pipeline and seeks to ensure that students are given a quality STEM education throughout their schooling. Given that college students will most immediately make up the nation's future workforce, STEM field college degree completion will be critical to maintaining competitiveness in the STEM areas.

If this critical shortage of the STEM labor force continues to increase, American businesses will find it difficult to remain competitive in the global marketplace (National Science Foundation, 2006; U.S. Department of Commerce, 2010). A 2012 report by the

President's Council of Advisors on Science and Technology (PCAST) reported that if the United States wishes to remain globally competitive, American higher education institutions will need to produce approximately 1 million additional STEM professionals over the next decade than are projected to graduate at current rates (PCAST, 2012).

Latina/o growth in the United States. The nation is experiencing a dynamic demographic and economic shift. Myers (2008) warns that an estimated 70 million Baby Boomers will retire over the next two decades, yet currently only 5 percent of the general U.S. population works in STEM-related fields. Unlike other fields which have seen decline, employment opportunities in STEM fields are expected to increase at least three times as much as other fields. In order to meet the needs of a globalized, competitive market, the United States must recruit and train significantly more STEM professionals, especially those of Latina/o origin (Myers, 2008).

Latina/os comprise almost 17 percent (Pew Hispanic Center, 2011) of the U.S. population, and in the near future will become the nation's largest racial/ethnic group. With Latina/os under age 18 now comprising more than half of the school-aged population in California, New Mexico, and Texas (Pew Hispanic Center, 2011), it is anticipated that by 2042, Latinos are expected to make up approximately 30 percent of the U.S. population (U.S. Census, 2008). Thus, given the demographic changes and economic imperative that the nation faces regarding its STEM workforce, it is crucial that more Latina/os progress through the STEM educational pipeline. Without tapping into the significant growth of this population and channeling that growth into meeting the STEM economic imperative, the United States fails to meet the needs of a growing

population and also risks the economic stability of the nation. In order to meet the economic and moral imperative for the STEM market, practitioners and scholars must first understand the enrollment and completion trends as well as the educational experiences of Latina/o students.

Between 1995 and 2009, as a result of the growing Latina/o population and increased K-12 educational outcomes, the Latina/o student college enrollment increased by 107% while enrollments only increased 15% for White Americans (Carnevale & Strohl, 2013). The Pew Hispanic Center found that Latina/os are now the largest minority group in the U.S. postsecondary education and, for the first time, are the largest minority group in four-year universities as well (Pew Hispanic Center, 2012). However, while Latina/o degree completion has grown, the number of degrees conferred on Latina/os still falls short of the educational success of other groups. The Pew Hispanic Center (Figure 1) reports that of the 1.7 million bachelor's degrees awarded in 2010, only nine percent were awarded to Latina/os while almost three-fourths were awarded to non-Hispanic Whites (71%) (Carnevale & Strohl, 2013).

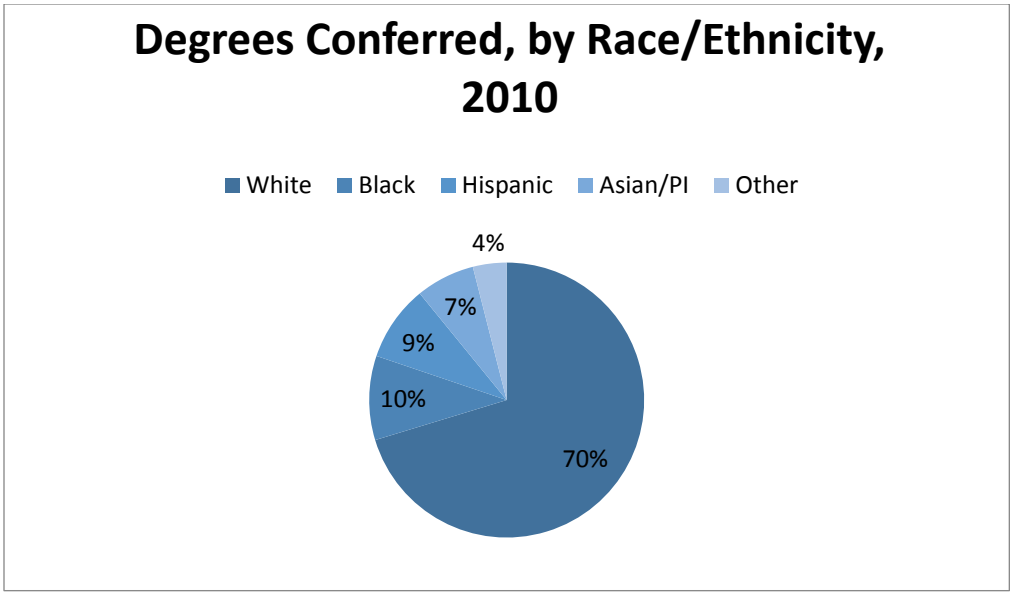

Figure 1. US Degrees Conferred by Race/Ethnicity 2010

Adapted from Table 297 in U.S. Department of Education, National Center for Education Statistics, "Digest of Education Statistics, 2011"

The Case to Study Latinas. Women of color occupy a precarious place in America, engaging in a "legacy of struggle" which simultaneously puts them at multiple intersections of oppression, including racism and sexism, with further challenges relating to the STEM cultural space (Collins, 2000). Researchers suggest that the underrepresentation of women of color in STEM fields is the result of a masculine, male-dominated, and culturally incongruent work culture (AAUW, 2010; Carlone, 2003; Williams & Ceci, 2007). STEM fields are also characterized as highly racialized, gendered spaces where women and people of color often encounter a culture characterized by White, masculine values and behavioral norms, disguised as an ideology of meritocracy (Carlone & Johnson, 2007; Johnson, 2001). Put together, these elements

create an environment for women of color that can be dually affected by both racism and sexism, causing women of color to experience greater challenges to STEM degree completion and transition to the workplace (AAUW, 2010; Espinosa, 2011).

Within the Latina/o community, Latinas do outpace their Latino male counterparts in overall degree completion (Saenz & Ponjuan, 2009). However, Latinas continue to lag behind other females, with only 14% of Latina students completing 4 years of college or more – a stark contrast when compared to White (29.3%), Black (20.6%), and Asian Pacific Islander (59.3%) females (U.S. Census Bureau, 2011). And, although overall Latina/o participation in higher education has increased dramatically, Latina/o participation and completion in STEM has not kept pace (Dowd, Malcom, & Bensimon, 2009).

In her study of Latinas in STEM majors, Santiago (2008) found that while over one-third indicated a desire to major in science and engineering fields, they currently represent only 1% of employed scientists and engineers. In 2006, Latina/os constituted 19% of the college-aged (18- to 24-year-old) population, however, only 8% of bachelor's degrees, 3.5% of master's degrees, and 4.4% of doctorates in STEM fields were awarded to Latina/os (Dowd, Malcom, & Bensimon, 2009). In addition, this study showed that Latina/os, both male and female, enrolled in STEM majors at four-year institutions at rates similar to Whites and African Americans, yet few progressed to complete undergraduate and graduate degrees (Dowd, Malcom, & Bensimon, 2009).

In a study of Latinas pursuing STEM fields, Excelencia in Education found that Latinas earned more than half of all bachelor's degrees awarded to Latina/os, however,

only 37% of those degrees were in STEM fields (Santiago, 2008). Of the degrees awarded to Latina/os in STEM fields, Latinas are primarily concentrated in biological and biomedical sciences (63%), rather than engineering and computer sciences (22%) or mathematics or physical sciences (45%). In fact, Latinas are outpaced by their Latino male counterparts in all STEM areas other than biology/sciences (Santiago, 2008). Underrepresentation continues past college with fewer Latina science and engineering Ph.D.'s employed as professors (11%), associate professors (15%), or assistant professors (37%). In contrast, Latino male Ph.D.'s represent professors (30%), associate professors (20%), and assistant professors (23%) (Santiago, 2008).

While substantial research has been conducted on *women in STEM* and on *students of color in STEM*, the experiences of *women of color in STEM* have been neglected in the research agenda until recently (e.g., Cantu, 2012; Espinosa, 2011; Ong et al., 2011). However, most of these studies focus broadly on women of color rather than provide a thorough understanding of the lived experiences of African American, Asian America/Pacific Islander, Chicana/Latina, and Native American female subgroups. Specifically, prior research has grouped Latinas in terms of their race/ethnicity (Latina/os), their gender (women), or the intersection of their race/ethnicity and gender more broadly (women of color). This research, however, has not formally extrapolated information pertaining to the unique individual experiences of the subgroup of Latinas in STEM, which help to paint a rich portrait of their collective experiences. Therefore, further research that addresses the elements of race/ethnicity and gender identities specifically for Latinas must be conducted in order to have a more nuanced view of the

science identity development of Latinas in STEM fields. Doing so would fill a needed gap in the literature as well as provide a basis for understanding how researchers, administrators, and policy makers can best enhance the STEM educational pipeline for the Latina/o community.

In essence, growing the number of Latina/os pursuing STEM fields is an important goal, both in terms of economic need as well as creating an equitable future. Scholars can bring greater awareness and understanding to this challenge by more fully understanding how the educational experiences of Latinas in STEM affect their educational experiences and science identity development during college. Further, the most immediate gains can be made by better understanding experiences of Latinas that persist within their STEM college majors.

Purpose of Study

The purpose of the study was to gain an in-depth understanding of how successful Latina college students develop and make meaning of their science identities. This research, framed by Carlone and Johnson's (2007) model of science identity and intersectionality, which highlighted the multidimensionality of the lived experiences of marginalized subjects, explored the relationships between science identity and other identities such as race, ethnicity, and gender, which may influence STEM experiences and science identity development.

The research study was guided by research questions which focused on how undergraduate Latinas, who have persisted in STEM majors at a tier-one predominantly white public research university, experienced science identity development:

1. How do Latinas develop and sustain their science identities during their college experience?
2. How do they make meaning of their formal and informal STEM experiences?
3. What is the relationship between science identity and other identities (e.g., gender identity, racial identity, socio-economic status identity)?

The primary theoretical framework, Carlone and Johnson's (2007) model of science identity examined the educational experiences of successful women of color throughout their undergraduate and graduate studies. This science identity model explored how women of color construct meaning from their science experiences and how larger society influences possible meanings. The grounded model of science identity included three overlapping key areas: science performance (performances of scientific practices, e.g., use of technical terms, tools), science competence (understanding of content), and science identity recognition (self and outside recognition as a "science person"). This model was informed by Gee's theory of identity (1999, 2000) which put forth the belief that "identity is, in part, informed by the 'kind of person' one is seeking to be and enact in the here and now" (p.13). In addition to the model of science identity (Carlone & Johnson, 2007), this study used an intersectional approach to capture the unique experiences of Latinas in STEM in relation to elements of gender, race, and ethnicity as well as to strengthen the overall framework for the research study (Crenshaw, 1991). Utilizing this approach, I examined the dynamic interplay of race, class, and gender inequality affecting the Latina STEM higher education pipeline to college graduation and development of science identity.

This study considered the lived experiences of 12 undergraduate Latinas majoring in the STEM disciplines at a tier-one predominantly white public research university in the southwest. The primary methods for data collection included: (1) pre-interview questionnaire, (2) phenomenological semi-structured interview, and (3) focus groups. For this study, two rounds of phenomenological semi-structured interviews and focus groups were conducted in a pattern of interview, focus group, interview, and focus group. Focus groups with the study's participants supported the semi-structured interviews by providing a social dynamic element and a space for reflecting with other undergraduate Latinas on their STEM experiences and science identity development.

After transcription, I used a phenomenological data analysis approach to organize the data in order to read and memo for significant quotes, and then I turned to describing and classifying the data into codes and themes. Finally, interpretations of the data's emerging themes are represented in the findings. The methods that were implemented for this study are further explored in Chapter 3.

Significance of Research Study

The study can simultaneously add to the empirical evidence that scholars have advanced on Latina/os and women of color in higher education as well as contribute to the knowledge base on Latina identity development and science identity development. This study is unique in its ability to fill a significant gap within the literature which has, until recently, failed to consider the dynamic relationship between racial, ethnic, and gender identities as related to the science identity development of Latinas. By utilizing Carlone and Johnson's (2007) model of science identity as a primary theoretical

framework and intersectionality as a secondary theoretical framework, this study can illuminate how undergraduate Latinas in STEM majors at a tier-one, predominantly white public research university navigate and make meaning of their experiences and develop their science identities over time, thus filling multiple gaps in the literature.

In terms of advancing theory, the study may deepen the understanding of Carlone and Johnson's (2007) model of science identity and the application to undergraduate Latinas in STEM majors. I will have the opportunity to explore each of the model's elements and how those elements resonate (or do not resonate) within the STEM educational experiences of the participants, particularly within the competitive STEM environment of a tier-one, predominantly white public research university. Finally, this study may add, clarify, or extend the science identity and intersectional theoretical frameworks employed in order to gain a more nuanced vision of the STEM experiences and science identity development of Latinas in college.

In terms of best practices and educational outcomes, the research study has the potential to inform both the formal and informal STEM educational experiences of Latinas. The study's findings may provide valuable information about STEM classroom experiences; faculty, tutor, and peer interactions; and the campus climate and norms which can illuminate key experiences for Latinas who persist within their STEM major and provide a basis of comparison with other women of color. Overall, this study seeks to enhance the knowledge base that scholars, administrators, and policy makers possess about the science identity development of Latinas in STEM. Thus, this study will assist these stakeholders in understanding the science identity development of Latinas in STEM

so that they can make informed recommendations that take into account other intersectional identities that may be present. Through the knowledge gained in this study, educational stakeholders will be able to enhance science identity development and, ultimately, improve undergraduate persistence and graduate school and/or workforce outcomes for Latinas in STEM.

Key Terms Defined

- *Asian or Asian American:* This term refers to people with origins in East Asia, Southeast Asia, the Indian subcontinent, and the Pacific Islands. Asian Americans include, but are not limited to, Americans of Bangladeshi, Cambodian, Chinese, Filipino, Hmong, (Asian) Indian, Indonesian, Japanese, Korean, Laotian, Malaysian, Pakistani, Sri Lankan, Taiwanese, Thai, and Vietnamese descent (Museus et al., 2011).
- *Black:* This term refers to people with origins in any of the Black racial groups of Africa or people with ethnic origins in the Black racial groups of the Caribbean, Central America, South America, and other regions of the world (Museus et al., 2011).
- *Competence*: This term refers to the scientific knowledge, skills, mindsets, and credentials that are necessary for scientists to possess (Carlone & Johnson, 2007).
- *Engineering fields*: These fields include aeronautical, architectural, astronautical, bioengineering and biomedical, chemical, civil, electrical, and mechanical engineering (Museus et al., 2011).

- *Ethnicity*: This word refers to an "identity based on a person's nationality or tribal group. Each racial group consists of many different ethnicities. Ethnicity is an identity based on membership in a segment of a larger society that does not share the same culture with other segments of society" (Museus et al., 2011).
- *Gendered Spaces:* areas in which particular genders of people, and particular types of gender expression, are considered welcome or appropriate. These spaces reinforce cultural gender norms and can regulate the relationships between men and women (Cohen, 2010).
- *Hispanic or Latino*: This term refers to a person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin regardless of race." (U.S. Census Bureau, 2011)
- *Hispanic Serving Institution:* A Hispanic Serving Institution (HIS) is defined as a college or university that has at least 25% Hispanic full-time enrollment, of which at least 50% are low income (Bordes & Arredondo, 2005)
- *Identity*: This term refers to the way in which an individual views himself as well as the way in which others view him (Gee, 2000).
- *Identity development* or *identity construction*: This term refers to how an individual's distinct personality in a particular stage of life is formed (Gee, 2000).
- *Intersectionality*: Refers to the intersections between different disenfranchised groups or groups of minorities; specifically, the study of the interactions of multiple systems of oppression or discrimination. (Crenshaw, 1991).

- *Math fields:* These fields include general mathematics, applied mathematics, and mathematical statistics (Museus et al., 2011).
- *Performance:* This term refers to the social performances of relevant scientific practices (e.g., talking like a scientist, acting like a scientist, using tools like a scientist, etc.) (Carlone & Johnson, 2007).
- *Race*: This term refers to "categorizations that are created by humankind based on the hereditary traits of different groups of people, thereby creating socially constructed distinctions…racial identification is complicated and racial categories overlap, meaning that one person can fit into two or more of the racial categories delineated." (Museus et al., 2011).
- *Predominantly white institution (PWI):* Refers to institutions of higher education in which White students account for 50% or greater of the student enrollment. The majority of these institutions may also be understood as historically White institutions within a historical context of segregated education. Contrasted with other colleges and universities that serve students with different racial, ethnic, and/or cultural backgrounds (e.g., Hispanic serving institutions, HSIs, or historically Black colleges and universities, HBCUs).
- *Racialized spaces*: Notions of race, which mediate the relationship between the institution and individuals. Racialization can determine power in these relationships, and ultimately, influence practice and policy (Feagin, 2006).
- *Recognition:* This term refers to the recognition of oneself and by others of being a "science person" (Carlone & Johnson, 2007).

- *Science fields*: These fields include environmental (earth sciences, oceanography), life

  (agricultural, biological, medical sciences, and physical (astronomy, chemistry, physics) sciences (Museus et al., 2011).
- *Science identity*: This term refers to how an individual thinks of herself as a scientist, as well as how others think of her as a scientist. It encompasses three components: competence, recognition, and performance (Carlone & Johnson, 2007).
- *STEM*: This term refers to the disciplines in science, technology, engineering, or math (NSF, 2010).
- *STEM culture:* This term refers to the knowledge, skills, mindsets, and tools that are traditionally required for an individual to know and uses in order to be accepted by professionals in the STEM disciplines (Carlone & Johnson, 2007).
- *Technology fields*: These fields include computer sciences, information sciences, as well as management information systems (Museus et al., 2011).
- *White*: This term refers to people with ethnic origins from Europe, White people of North

  Africa, or people of the Middle East (Museus et al., 2011).
- *Women of color:* A term containing both ethnic and racial components which refers most often to a woman who identifies as American Indian or Native American, Asian or Asian American, Black or African American, Latina or Hispanic. (Carlone & Johnson, 2007)

Organization of Study

This dissertation is organized into seven chapters, plus appendices and references. Chapter one provided an overview of the problem, the purpose and significance of the study, and a brief description of the theoretical framework and methodology that was implemented in the study. This chapter also described key terms as well as the significance of the project and the contributions that the finished product made on literature within the field, theory building around science identity, and recommendations for best practices with Latinas in STEM disciplines.

Chapter two provides a review of the literature relevant to the science identity development of Latinas in STEM at a tier-one, predominantly white public research university and an examination of the primary and secondary theoretical frameworks that guide the research study. This chapter is organized around sections, which discuss factors affecting Latina STEM persistence and completion, existing Latina/o identity development models, and science identity development models.

Chapter three addresses the methodology of the research study, including the research design, site and participant selection, data collection and analysis, trustworthiness, limitations, and delimitations. Specific methods for the study are highlighted here as well as descriptions of the data collection and analysis processes. In addition, this chapter covers the strategies for data confidentiality and trustworthiness of the overall study.

Chapter four provided vignettes of each of the study's participants, including key information related to STEM experiences. The purpose of these vignettes is to

contextualize and clarify the research study's findings as they are situated within the complex nature of life. Each vignette presents a brief introduction to the student, including pre-college and college experiences, and concludes with brief summary of the student's short- and long-term goals associated with their pursuit of the STEM fields.

Chapter five, aimed at answering the first and second research questions, utilized the study's primary theoretical framework related to science identity development to understand science identity development (Carlone & Johnson, 2007). Utilizing this science identity development model for analysis examined how the Latina students in this study made meaning of their STEM experiences and developed their science identities.

Chapter six, aimed at answering the third research question, used an intersectional approach to examine the study's data at the intersections between various identities. Utilizing this approach to analysis allowed for the exploration of how Latinas in this study made meaning of their STEM experiences in light of their multidimensional identities.

Chapter seven of this dissertation served as a discussion space for situating the findings of this study into the current literature and provided an outlet for exploring the implications of this work on research and practice. This chapter concluded with a section describing the future research, which needs to be conducted on science identity development for Latinas.

The appendices include documents related to participant recruitment as well as semi-interview and focus group protocols.

Chapter 2: Literature Review

As part of my research study, it was imperative to review the existing literature to acquire a comprehensive understanding of the experiences of Latina undergraduates in STEM and identify gaps in knowledge that may exist. A critical review and synthesis of the relevant literature informs my research study in significant ways, both guiding my choice of theoretical frameworks in which to situate this work and methodological approaches to data collection and analysis. The literature review focuses primarily on empirical studies published within the last decade, which focus on STEM experiences and science identity development. These studies were drawn from multiple areas of research, including more general areas, such as the experiences of students of color or women in STEM fields to more nuanced areas, such as Latina/os or women of color in STEM fields as well as established and emerging identity models.

Chapter 2 consists of two major sections, including a literature review of relevant empirical studies as well as an examination of the primary and secondary theoretical frameworks used to guide this research study. Within the first section, the literature review is comprised of four sub-sections: (1) barriers to STEM student achievement and persistence, (2) institutional factors, (3) Latina/o identity development, and (4) science identity development. The first sub-section examines literature related to STEM student achievement and persistence, including academic experiences, psychological factors, and socio-cultural factors. The second sub-section describes literature related to institutional factors of student success and campus/departmental climate. The third sub-section examines multiple models of Latina/o identity development that have emerged over time.

The fourth sub-section explores the literature related to science identity development and its relationship to STEM student achievement and persistence. Literature related to women of color in STEM, and, when possible covering specifically Latinas in STEM, has been weaved throughout each of the four sub-sections. Taken together, the literature review synthesizes prior research related to the educational success of Latinas in the STEM pipeline and identifies where the major gaps in the literature exist.

The concluding section of the paper introduces primary theoretical framework, Carlone and Johnson's (2007) model of science identity, and the secondary theoretical framework, the theory of intersectionality. These major theoretical frameworks, paired with the literature review, serve to advance the study by situating this work within the body of existing research and utilizing an analytic lens of identity to explore the experiences of Latinas in STEM disciplines at a tier-one, predominantly white public research university.

Barriers to STEM Student Achievement and Persistence

A growing body of literature suggests the importance of understanding how a multitude of factors, academic and beyond, converge to influence Latina student decisions to enroll and complete STEM degrees and transition into the workforce. According to Flores (2011), many of the academic obstacles Latina/o students face relate to curricular, structural, and cultural issues surrounding their STEM education. Women of color often struggled with attaining pre-college STEM achievement, engaging with school-supportive STEM environments, and obtaining a high level of support from STEM educators (Chinn, 1999). Latinas, as individuals who are simultaneously part of

the Latina/o community and the women of color group, face a unique set of barriers to STEM achievement and persistence.

This sub-section examines literature related to the academic experiences, psychological factors, and socio-cultural factors which affect Latina STEM student achievement and persistence in the educational pipeline. Within each of these sections, the literature may refer to the barriers existing for Latina/o students, students of color, or women of color as a group, rather than Latinas specifically, as existing research, in many cases does not disaggregate the experiences of Latinas in STEM.

Academic Factors. Latina students experience barriers to STEM academic achievement throughout the P-20 educational pipeline. Latinas who developed STEM interests early were more likely to understand the process, and subsequent steps, associated with achieving their career goals (Reyes, Kobus, & Gillock, 1999). Nonetheless, Latina/o students experience the highest high school dropout rate for any racial or ethnic group – approximately 23% of Latina/o students between the ages of 16-24 dropout before graduation, leaving fewer Latinas to persist in STEM fields (U.S. Department of Education, 2009). At the post-secondary level, Latinas make up just over four percent of the STEM bachelor's degrees awarded (Ong, et. al, 2011).

Gaps in higher education educational outcomes for Latina/o students result from persistent disparities in educational conditions for these students, beginning as early as elementary school and continuing through secondary school. Educational trends suggest that the Latina/o STEM achievement gap emerges early in the educational pipeline, and although it shrinks by fifth grade, it reemerges after eigth grade (Reardon & Galindo,

2009). Furthermore, this study reveals that Latina/o students, particularly those from Mexican and Central American origins, tend to enter kindergarten with math skills significantly lower than those of White students.

Although this research study focuses on the role of college STEM experiences and science identity development, pre-college academic experiences are essential to understanding the journey that Latinas have been on since they began their education pathway. Latina students face may face many obstacles related to their academic experiences prior to arriving on a college campus (Cantu, 2012; Crisp & Nora, 2012; Crisp, Nora, & Taggart, 2010). Several pre-college experiences have been shown to positively influence Latina/o student interest and participation in STEM majors, including students with adequate STEM preparation (Tyson, Lee, Borman, & Hansen, 2007), high test scores, (Rakow & Bermudez, 1993), and affirmative academic experiences in mathematics and science prior to secondary school (U.S. Government Accountability Office, 2005; Simpson, 2001). These predictor elements create a barrier for many Latina/o due to a shortage in resources needed to enhance their science and mathematics learning experiences (Crisp & Nora, 2012).

Throughout the K-12 pipeline, Latina/o students pursuing STEM interests may encounter insufficiently designed curriculum and instruction and limited learning opportunities and resources with effective interactions with educators (Taningco, 2008). STEM training at the elementary and secondary levels not only influences academic preparation in these fields, but also shapes overall interest in high school coursework and the potential for pursuing STEM-related careers (U.S. Government Accountability

Office, 2005). Therefore, the more rigorous the curriculum and stronger the student's background in STEM education, the more likely it is that this student will persist to a career in this area.

Latina/o students are less likely to receive accessible, high-quality instruction and equitable funding, further discouraging interest and the ability to succeed in STEM fields (Chacon, 2000; Triana & Rodriguez, 1993; Young, 2005). A lack of quality academic instruction and teacher preparation may be a reality for Latina students, given disparities of STEM funding for Latina/o and other underrepresented students within school districts. These educational disparities are a function of the existing educational system, which highlights Latina/o student deficits and is academically and culturally inappropriate to meet the holistic needs of these students (Solorzano, Vilalpando, & Oseguera, 2005).

The number of STEM courses taken by high school students can often serve as a strong predictor of choosing one of these areas as a college major (Astin & Astin, 1992; Simpson, 2001), however, this often acts as a barrier for Latina/o students, and other minorities, due to a lack of STEM learning resources throughout the educational pipeline (Auerbach, 2004). Crisp and Nora (2012) suggest that mathematical and science experiences at the elementary and secondary levels influenced building of preparation and interest in pursuing mathematics and science coursework and eventual desire to pursue a career in the STEM disciplines. Particularly the number of science, mathematics and English courses taken by Latina/os students while in high school served as a predictor for choosing a college STEM major. However, May and Chubin (2003) found

that Latina/o students, instead, were overrepresented in remedial classes and severely underrepresented in advanced placement courses needed for college preparation, presenting barriers between these Latina/o students and STEM career aspirations. Taking into account that many postsecondary factors, including admissions and financial aid, are dependent upon academic experiences prior to college, these experiences are hallmark to understanding postsecondary outcomes.

For Latina/os, educator interactions played an important role in the support and achievement of students pursuing STEM disciplines. Although traditional models student departure (e.g. Tinto, 1993), suggested that faculty interaction as an important factor of college persistence, more recent literature concerning Latina/o students suggested that the type and quality of faculty interaction may vary by discipline and race/ethnicity (Garcia and Hurtado, 2011). Garcia and Hurtado (2011) suggest that an increase in faculty support and guidance is often associated with a lower the likelihood of Latina/o STEM persistence. Although seemingly counterintuitive, the authors recognize that this finding cannot necessarily mean that students who have more faculty interaction are more likely to depart but rather that those who rely perhaps too heavily on their faculty members are, as a result, more likely to depart. This study highlights the need to examine Latina STEM experiences in terms of the types of support that these students receive in in a variety of contexts. Specifically for women of color in STEM, high school grades, high school type, and the level of support that they receive from counselors/teachers during their pre-college years provide predictors of STEM education success (Chinn, 1999). As early as junior high school, Latinas may be more hesitant to ask questions during class,

less likely to acknowledge that they are looking forward to eighth grade mathematics classes, and are the least likely to possess STEM career aspirations (Catsambis, 1994).

Gender is one of the most powerful predictors of college major choice for students of color and women of color are more likely to pursue liberal arts, health, public service or business degrees than STEM career aspirations (Simpson, 2001). At the college level, positive classroom experiences, including the use of effective pedagogy, are vital to the success of women in STEM majors (Seymour & Hewitt, 1997) and were key linkages to connect content with long-term academic goals (Alfred et al., 2005). Women of color who engage with peers to discuss course content, engaged in major-related clubs, and participated in research programs are also more likely to persist. However, in some instances, gender, race, and ethnicity became major challenges to the educational experiences of women of color, especially when peers or faculty did not recognize them as serious science students (Carlone & Johnson, 2007; Seymour & Hewitt, 1997). STEM major persistence is also often closely correlated to standarized test scores (Garcia & Hurtado, 2011), high school percentile (Crisp, Nora, & Taggart, 2010), high school GPA (Herrera & Hurtado, 2011) and the number of STEM advanced placement courses taken during the high school years (Griffith, 2010).

Yet, few researchers have attempted to investigate Latinas, separate from the larger Latina/o community and women of color, or understand how Latinas make meaning of their science and mathematics academic experiences. Crisp and Nora (2012) touch briefly on factors that are specific to Latina STEM educational success, however, it is not discussed in depth. *Excelencia in Education* (2008) released a fact sheet on Latinas

in STEM fields, highlighting their lower levels of enrollment, persistence, and integration into the workforce; however, this document did not go into detail regarding academic factors for success. Sayman (2013) examined Latina STEM academic experiences in depth, highlighting the importance of teacher pedagogy, small classroom sizes, collaborative learning and creating a teacher connection, however, these findings were within the extremely unique context of state-supported residential schools of science and math, making transferability difficult.

Cantù (2008, 2012), in both research article form and expanded book form is an exception. Through the use of Latina scientist and engineer *testimonios*, the author revealed that STEM academic preparation, teacher encouragement, and English language and reading proficiency were important factors in the successful persistence of Latinas through the STEM pipeline. Participants within this study emphasized the role of STEM educational pathways and the need for a strong science and mathematics curriculum throughout one's academic career. In addition, participants identified teacher encouragement as a means to supporting their STEM interests and acknowledged their achievement as a product of their English and reading proficiency. However, the *testimonios* shared in the research article and the book relate the educational experiences of Latina scientists, mathematicians, and engineers, some of which span several decades and may not reflect the current state of education nor the contemporary issues that undergraduate Latinas must face.

A review of the literature concerning the academic experiences of Latinas in STEM reveals three key take-aways. First, the research study must be informed of the

structural and curricular inequalities as well as the lack of resources which exist for Latinas in STEM, both as members of the Latina/o community and as women of color. Second, it must also acknowledge that STEM college experiences are the result of building blocks of a myriad of STEM educational experiences that have occurred within K-12 educational system. Third, the study must account for the fact that psychosocial and sociocultural aspects of an individual student's life may influence the STEM experiences and opportunities that this student has in moving towards or away from STEM aspirations. These take-aways guide the study to consider pre-college academic experiences in science and mathematics as well as psyco-social and sociocultural factors which may influence the STEM educational pipeline for Latinas. Given the study's context at a tier-one predominantly white public research university, each of these considerations may be key in understanding the academic experiences of Latinas in STEM majors. The pre-interview questionnaire and interview/focus group protocols address these STEM academic considerations in order to more fully explore the meanings that participants attach to their experiences.

Cognitive and non-cognitive Factors. The STEM achievement of Latinas may be influenced by a host of cognitive and non-cognitive factors during their STEM experiences. Scholars have suggested several factors affect STEM degree attainment for students and women of color, including self-concept, self-efficacy, and drive (Bandura, 2010; Chang et. al., 2010; Leslie, McClure, & Oaxaca, 1998; Nora & Crisp, 2012; Ong et al, 2010).

Positive academic self-concept and increased self-efficacy are factors associated with elevated levels of involvement and higher achievement among minority STEM college students (Bandura, 2010). If students believe that they possess a strong science/math background and have the ability to perform well in these areas during college, they are more likely to major in a STEM discipline (Leslie, McClure, & Oaxaca, 1998). This trend holds true for students of color who, when they possessed a higher academic self-concept when entering college, were more likely to persist in their STEM major to graduation (Chang, et al., 2010).

Several studies examined the academic self-concept of women, including documentation of the lower the levels of confidence, which were developed by women of color over the four years of college. Women of color in STEM have been shown to decrease math confidence during college and to have lower levels of math self-efficacy upon entering and persisting through college when compared to male peers (Giguette, Lopez, & Schulte, 2006). For African American women, a strong relationship was determined to exist between science self-efficacy and the choice of a scientific major (Gwilliam & Betz, 2001) as well as math ability and choice of STEM major (Maple & Stage, 1991). According to Shain (2002) self-confidence has also been shown to be a key factor in the educational success of African American female engineering majors who are often called upon to adjust to the rigors of the engineering environment (Shain, 2002).

Because the majority of Latina/o students who are admitted to college as STEM majors come from high schools where they were they excelled academically, these students may be surprised to find that they lack the knowledge and skills required to

excel in rigorous college courses, and, too often, switch to a less demanding major or dropout altogether (Seymour & Hewitt, 2007). Making such decisions may cause Latina/o students, and other underrepresented minorities, to experience stereotype threat, a minority student's fear of being reduced merely to a negative stereotype (Steele & Aronson, 1995). Connected to issues of stereotype threat, are issues of imposter phenomenon, which results when individuals are unable to recognize accomplishments as the result of personal competence and, instead, attribute that success to external factors (i.e. luck, chance, positioning) (Clance & Imes, 1978). Women are more likely than their male counterparts to experience imposter phenomenon due to the influence of gender role stereotypes and socialization as a woman (Clance et al., 1995; Powell, 1999; Swim & Sanna, 1996). In addition, women's personal investment in STEM disciplines is regarded as substantially lower than that of men, which may result from imposter phenomenon and the greater likelihood to question their true level of talent and disturb their academic self-concept with the STEM domain (Else-Quest, Hyde, & Linn, 2010; Mendez, Mihalas, & Hardesty, 2006; Stout, Dasgupta, Hunsinger, & McManus, 2011). Feelings of helplessness in this situation not only have the potential to undermine a Latina/o student's science identity and deny the student the ability to "perform" and gain competence in their individual STEM discipline, but also may prevent the student from being recognized by those around them, such as peers, teaching assistants, and faculty members (Carlone & Johnson, 2007).

Student self-efficacy, or personal agency, and drive are also major predictors in the decision to pursue and ability to persist in STEM fields (Carlone & Johnson, 2007;

Ellington, 2006; Ong, 2002, 2005; Ong et al., 2011; Post-Krammer & Smith, 1986; Varma, 2002). Women of color have been shown to develop self-efficacy and drive as they persist through the STEM undergraduate pipeline (Ellington, 2006). Women of color utilize their status as a member of two underrepresented groups – as a woman and as a person of color – to empower themselves against the challenges of racism and sexism which may exist within the STEM environment (Ong et al., 2010). Similar findings are present for Latina/o students (Stevens, Olivarez, Lan, & Tallent-Runnels, 2004). Latina/o students have exhibited lower levels of self-efficacy in relation to science and mathematics (Leslie, McClure, & Oaxaca, 1998; Stevens, Olivarez, Lan, & Tallent-Runnels, 2004). Latina/o students may have difficulty viewing themselves as potential scientists or mathematicians, even though they express interests in those careers (Sorge, Newsom, & Hagerty, 2000). Even if Latina/o students do exhibit positive self-concept and self-efficacy, these concepts may be more complicated for Latina/o students than they appear. Latina students at minority-serving institutions often achieved their undergraduate degree through personal drive (Varma, 2002) or, as noted by Valenzuela (2006) through cultivating personal strength, confidence and competence within their area of study.

A review of the literature concerning these cognitive and non-cognitive factors related to the educational experiences of Latinas in STEM reveals three key take-aways. First, the research study must seek to add to the existing literature by investigating how Latinas in STEM disciplines make meaning of their STEM educational experiences and interactions and develop academic self-concept. Second, it must also acknowledge that

Latinas experience a duality around being both a woman as well as a person of color which may affect the manner in which they develop science identities. Third, the study must explore the strong, personal force that the literature hints at but does not seem to fully explore for women of color. These take-aways guide the study to consider how Latinas come to possess a positive academic self-concept, which may affect the way in which they are recognized and recognize themselves as a "science person." In addition, given the fact that women of color utilize their statuses as both a woman of color and a person of color for empowerment, this study is guided by the desire to understand how Latinas in STEM negotiate multiple identities while in college.

Socio-cultural Factors. STEM access and persistence are also the result of a variety of socio-cultural factors. Latina/os from Mexican and Central American origins, tend to enter kindergarten with math skills significantly lower than those of White students, with patterns suggesting that aspects beyond those at the school (e.g. socioeconomic status, language, immigrant status) are in part responsible for the Latina/o-White achievement gap, especially for the most socioeconomically disadvantaged (Reardon & Galindo, 2009).

For women of color in STEM disciplines, familial and community support were among some of the most important factors for academic success (Ong et al., 2010). Familial ties, especially to mothers of women of color, can be a source of encouragement, acceptance, and academic expectations; however, these relationships can also be a source of tension if familial expectations and goals for their daughter do not align with her own (Ong, et. al, 2010). For Latino families, this influence plays a role in inspiring student

interests and career development in STEM (Catsambis, 1994). Parental encouragement is one of the strongest influences on educational aspirations of Latina/o students (Arbona & Nora, 2007). Socio-cultural factors, such as gendered practices, may discourage Latino families from encouraging their daughters towards traditionally masculine career fields like those of STEM disciplines (Gasbarra & Johnson, 2008; Taningco, 2008). Culturally, Latino families may be hesitant to encourage their daughters to pursue a career in a traditionally male-dominated field. Furthermore, Latinas are often segregated into careers associated with "carework," such as teaching and social service jobs, rather than those associated with scholarship and industry (Castanzarite & Trimble, 2008). Latinas who were raised in predominantly patriarchal family structures were much more likely to pursue STEM careers their peers (Reyes, Kobus, & Gillock, 1999).

In addition to family, peer influences affected the decision to pursue a STEM field for students and women of color. Astin and Astin (1992) found student major was greatly influenced by the number of their friends and peers who had received or were seeking a degree in a particular area of study. In addition, advice or support from peers, upper-classmen, graduate students and/or teaching assistants are important to developing and sustaining a student of color's sense of belonging (Hurtado et al., 2007). Patterns of socialization differed for Latinas who sought more traditionally male-dominated careers (Reyes, Kobus, & Gillock, 1999). Latinas who preferred having "American" friends and using English were much more likely to pursue STEM careers (Reyes, Kobus, & Gillock, 1999). Latinas reported a greater desire to socialize with a more heterogeneous group when compared to Latinas aspiring to traditionally female-dominated careers. Reyes, et

al. (1999) hypothesize that exposure to a more diverse set of ideas that are not gender-restricted may encourage Latinas to consider more possibilities, including majoring in STEM fields.

A review of the literature concerning the socio-cultural factors related to the educational experiences of Latinas in STEM reveals two key take-aways. First, the research study must consider the socio-cultural structures that Latinas in STEM are immersed in and the inherent values, opportunities, and challenges that may come with those existing socio-cultural structures. Second, it must also examine the role that family and peers have in the development of Latinas in their STEM majors, especially given the social norms centered upon family and the unique role that STEM peers may play in the persistence process. These take-aways undergird the selection of the primary and secondary theoretical frameworks which highlight the complex nature of science identity development for Latinas as a result of a variety of STEM experiences and intersecting identities. In addition, understanding the literature around socio-cultural aspects of the Latina STEM college experiences has informed the interiew and focus group protocols as well as the pre-interview questionnaire. Each of these items was designed with a conscious thought towards potential socio-cultural influences for Latinas during their STEM educational journey.

Institutional Factors

The type of institution Latina/o students decide to attend has been identified as a factor influencing access and persistence in STEM fields (Grandy, 1998; Griffith, 2010; Herrera & Hurtado, 2011; Hurtado & Chang, 2010). Students of color who attend four-

year institutions as opposed to community colleges were more likely to complete a STEM major (Grandy, 1998). However, a disproportionate number of Latina/o students are concentrated in the two-year college system, decreasing their odds of majoring in STEM (Pew Hispanic Center, 2005).

Attending a private institution is a predictor of success for students of color, but attending a selective institution has the potential for a negative influence on the persistence of students of color (Herrera & Hurtado, 2011). In the Herrera and Hurtado (2011), the researchers found a negative relationship between institutional selectivity and the sense of belonging for students of color within their first year of college. Furthermore, all students of color who attended highly selective institutions (regardless of minority-serving status) were less likely to persist in STEM majors (Chang, Cerna, Han, & Saenz, 2008). Within the Chang, Cerna, Han and Saenz (2008) study, the rate of persistence for students of color decreased as the level of selectivity increased for both predominantly White institutions and Hispanic-serving institutions.

Institutional characteristics related to the offerrings and make up of the campus community were also found to be important to the success of students of color. Hurtado and Chang (2010) found that the number of retention programs and undergraduate research opportunities offered by a campus had a positive relationship to the STEM degree completion rate at the institution. In addition, the ration of undergraduate to graduate students, the female make up of the STEM faculty, research and educational spending, and the percentage of doctoral students of color were all positively related to the decision of a student of color to persist in a STEM major (Griffith, 2010). Also,

sustained interest in STEM for students of color has been found to positively correlate with the percentage of students enrolled in STEM majors at an institution – suggesting that the more STEM majors that an institution has, the greater the chance of sustained interest and persistence in STEM for students of color (Herrera & Hurtado, 2011).

Campus climate research indicates that students of color generally find campus climates to be less supportive and isolating in comparison to their White peers (e.g., Harper & Hurtado, 2007; Museus, Nichols, & Lambert, 2008; Nora & Cabrera, 1996). Students of color, especially women of color, on campus may find that they lack the required cultural capital and feel a sense of incongruence between their knowledge, skills, and mindsets and those of the institution (Dennis, Phinney, & Cuateco, 2005). Cultural capital theory (Bourdieu, 1984) seeks to explain the systemic struggles of non-dominant groups for upward mobility and the "cultural capital" that must be acquired in order to understand the norms and values of the dominant group. Students of color and women pursuing the traditionally White, male-dominated STEM fields must be socialized to these new norms in order to achieve success. Thus, a STEM student's ability and willingness to learn and adapt to these norms plays a critical role in determining the level of cultural capital that this student possesses and the level of success that he or she will experience in STEM disciplines (Rypisi, Malcom, & Kim, 2009).

Cultural congruity includes the knowledge, skills, and mindsets that are transferred from parents to students (Bordieu, 1984). Dennis, Phinney, and Chuateco (2005) suggest that White and Asian American Pacific Islander (AAPI) students are more likely to have access to cultural capital from their parents, preparing them better for the

college experience – being more culturally congruent with the given norms. In contrast, Latina/o students often do not have access to such cultural capital and experience cultural incongruity. This happens when minority or low socio-economic students find themselves immersed in values which are not their own, leaving them to feel culturally isolated during their college years (Gloria & Rodriguez, 2000).

Climates in STEM departments can be even more important to shaping the experiences of women of color. Researchers assert that STEM climates are often hostile and can perpetuate feelings of discouragement and departure for students of color, including Latina/o students, within these disciplines (Fries-Britt, Younger, & Hall, 2010; Gloria & Kurpius, 2001; Hurtado et al., 2007). Therefore, these students must grapple with challenges from both campus and STEM departmental climates. Particularly for women of color and Latinas, the STEM climate can be both harshly competitive and threatening on multiple fronts. The competitive climate is considered threatening to women as it is in conflict with women's established preferences for collaboration and interpresonal relationship building (Seymour & Hewitt, 1997). This highly threatening environment compounds the adjustment that women of color from all groups must make in transitioning to the predominantly White, masculine STEM environment within their first year of college (Hurtado et al., 2007). Research indicates that women who are willing to challenge gendered societal expectations may be better able to withstand the sexism of the STEM workplace than women who adhere to gender norms (Eisenhart & Finkel, 1998).

A review of the literature concerning the socio-cultural factors related to the educational experiences of Latinas in STEM reveals two key take-aways. First, the research study must take into account institutional context, as it shapes the campus and departmental cultural norms, expectations, and sense of belonging for Latinas in STEM disciplines. Second, it must also explore accumulated cultural capital and level of cultural congruency of the Latina STEM major research participants in order to more fully understand their STEM experiences and science identity development. These take-aways have had a significant influence in the placement of this study at a tier-one predominantly white public research university. Because prior research suggests that students of color will experience lower levels of success in this type of setting, it is particularly important to understand the elements of the research participant's experience which have allowed her to persist within her STEM major in this context. A consideration of such instutional factors has framed the questions on the interview and focus group protocols and aided me in understanding the campus and STEM cultures in greater detail.

Latina/o Identity Development Models

This section moves away from STEM related literature to discuss the literature related to identity development models for Latina/os. As the Latina/o population of the United States continues to grow, increased attention has been focused on understanding Latina/o identity. Because Latina/os do not easily fit within traditional models of race or ethnicity, or the traditional models of ethnic identity development, understanding Latina/o identity development presents exceptional challenges (Ferdman & Gallegos,

2001). Reviewing prior models serves as a means for situating the research study among other identity development models for the Latina/o community and moving towards a more nuanced understanding of the Latina/o identity development experience. [2]

Amid educational experiences and the environmental factors that Latinas encounter, a growing body of literature explores Latina/o and science identity development. Keefe and Padilla (1987) examined Chicano (Mexican American) identity development in terms of cultural awareness, ethnic loyalty, and ethnic social orientation. They defined these terms in the following ways: (a) *cultural awareness* as an awareness of the people and culture of Mexico, (b) *ethnic loyalty* as the feelings and preferences about Mexican culture, and (c) *ethnic social orientation* as the desire for interacting with other individuals of Mexican descent and for eating traditional foods. Through this model, Keefe and Padilla (1987) sought to create a "sophisticated and empirically based conceptualization of what it means to be a Chicano", and, as a result, they created the typology of Mexican American ethnic orientation (p. 1). This typology has five types, which range from Type I individuals, who are unacculturated and identify closely with Mexican people and culture, to Type V individuals, who are highly Anglicized and have little knowledge of or identify with Mexican culture or social spheres. Although the middle types are more challenging to differentiate, Type III, the largest group of individuals, are often considered bicultural due to their ability to balance Mexican and Anglo cultural orientations. The model has been critiqued in several ways, including

[2] For the purposes of this section, the research has chosen to utilize the naming terms of the model (i.e. Hispanic or Chicano versus Latina/o) for the sake of clarity to the reader and it is not meant to undermine the differences between each of the terms of assume that these terms are interchangeable.

observations that the model (a) fails to address issues related to Latino identity formation cycles, (b) lacks a discussion regarding dual-culture socialization and biculturalism, and (c) falls short in its consideration of individual differences and self-reports of acculturation patterns (Padilla, 2006; Padilla & Perez, 2003; Torres, 2003; Torres, Martinez, Wallace et al, 2012).

Ferdman and Gallegos (2001) put forth a Latino identity development model to examine how the umbrella term "Latino" as well as explore how Latinos develop orientations based on experiences with social institutions including the family, education system, peer groups and U.S. cultural racial constructs etc. The model describes seven distinct orientations for how Latino identity is perceived: (a) Latino Integrated, understanding of racial constructs and ability to challenge them, (b) Latino Identified, acceptance of the races Latino and White and identification with Latino, (c) Subgroup Identified, identification of multiple Latino races and identification with a regional subgroup, (d) Latino as Other, identification as a generic Latino due to mixed heritage, (e) Undifferentiated, colorblindness, adherence to dominant culture, and tendency to attribute failure to the individual rather than racial constructs, and (f) White Identified, acceptance of White and Latino races and identification with White and rejection of Latino. This model does not address elements of multiple orientations, describe movement between orientations, nor are strengths associated with each orientation clearly defined. The authors do suggest that further research should explore the factors, which lead to each orientation.

In response to earlier models, Torres (1999, 2003) utilized a longitudinal approach to demonstrate the importance of correlating ethnic identity and level of acculturation among Hispanic college students. According to Torres (2003), "[a]cculturation looks at the choices made about the majority culture, whereas ethnic identity looks at the maintenance of the culture of origin" (p. 533-534). Torres outlines four major orientations for Hispanic students: (1) bicultural orientation or a preference to function competently in both the Hispanic and Anglo cultures, (2) Anglo orientation – a preference to function within the Anglo culture, (3) Hispanic orientation – a preference to function within the Hispanic culture, or (4) marginal orientation – the inability to function adequately within the Hispanic or Anglo cultures. Torres's longitudinal study identified two major categories of Hispanic identity development: situating Identity and influences on change in identity development. This model emphasize how the influences of where they grew up, generational status, and self-perception of societal status affect how these students perceived their culture and environment as well as situated their Hispanic identity.

A review of the literature concerning the identity development models for the Latina/o community reveals three key aspects. First, the research study must consider the multifaceted nature of Latina/o identity development, given the broad range of characteristics and experiences within the population. Second, it must also acknowledge the fact that identity development is dynamic, rather than static, and students may not easily fit into given categories of identity development or may be between stages or outside of the bounds of the model. These take-aways have had a significant influence in

the consideration of Latina identity development within the STEM context. In addition, this literature has helped to inform the selection of the research study's primary and secondary frameworks to include identity frameworks which consider the racial, ethnic, gender, and other identities present within the research participants.

Science Identity Development

Scholarship concerning the concept of "science identity" is growing at an even more rapid pace (e. g., Aschbacher, Li, & Roth, 2010; Carlone & Johnson, 2007; Chemers, Zurbriggen, Syed, Goza, & Bearman, 2011; Hazari, Sadler, & Sonnert, 2013; Herrera, Hurtado, Garcia, & Gasiewski, 2012; Hughes, 2001), given the STEM imperative. However, the concept remains amorphous and, as Carlone and Johnson state, "difficult to operationalize in a ways that provides solid methodological and analytic direction" (2007, p. 1189). Carlone and Johnson (2007) define science identity as a reflection of how one understands and positions oneself within the STEM culture and how others within that culture recognize them. Lave (1992) proposes a complementary perspective from which we might view the study of science identity development:

> Learning is, in this purview, more basically, a process of coming to be, of forging identities in activity in the world. In short, learners are never only that, but are becoming certain sorts of subjects with certain ways of participating in the world. (p. 3)

Taken together, these perspectives suggest that STEM students are active participants within their experiences, actively moving towards, or perhaps away in some cases, a science identity.

`If scholars are to view the STEM fields as a community of practice into which aspiring STEM students must be enculturated, such as Lave believes (1992), then it is

important to understand how those aspiring STEM students associate or become alienated from the community and its norms and culture (Carlone & Johnson, 2007). Therefore, STEM experiences, subsequent enculturation into the STEM, and eventually entering a STEM career is all part of the science identity development process (Christidou, 2011).

The science identity development of girls is shaped by whether and how they view themselves as the "kind of person" (Brickhouse, Lowery, Schultz, 2000, p. 1) who engages in science. As early as elementary school, male and female students believe the stereotype that physical science subjects are male-appropriate and life sciences are female-appropriate (Farenga & Joyce, 1999). Science identity research at the middle school level reveals that girls, of all races and ethnicities, explore how they will view themselves and whether or not they are the kind of female science-engaged person (Brickhouse, Lowery, & Schultz, 1999). By high school, young women find it easier to envision a STEM career if they experience high levels of academic achievement within the mathematics and science classroom and feel encouraged in their abilities and interests, thus developing their science identity (Aschbacher, Li, & Roth, 2010). Science identity development influences STEM interest and persistence, particularly for women of color (Brickhouse, Lowery, & Schultz, 2000; Carlone & Johnson, 2007). Therefore, exploring science identity development for women of color is crucial to understanding how her identity will develop over time and whether or not that student will be validated or rejected as a science-engaged female.

A review of the literature concerning science identity development models reveals several key take-aways. Despite the growing body of knowledge of the experiences of

Latina/os pursuing STEM fields, researchers fail to fully address Latina/o student identity development in this area. Although identity development for women and women of color, both within and outside of STEM, are areas that have been explored over the past decades (Carlone & Johnson, 2007; Josselson, 1987), as well as identity development for Latina/os as a group (Keefe & Padilla, 1987; Padilla, 2006; Padilla & Perez, 2003; Torres, 2003; Torres et al., 2012), research has not empirically explored the area of Science identity development for Latina college students in a meaningful way. A gap in the literature exists regarding the investigation of Latinas, separate from the larger Latina/o community and women of color, in order to understand how Latinas make meaning of their science and mathematics academic experiences. This gap is particularly troublesome, considering that in their study of science identity development, Hazari, Sadler, and Sonnert (2013) found that Latinas tended to be the most disempowered in their views of themselves with respect to science. This study suggested that Latinas, out of all the racial/ethnic subgroups, may face the greatest challenges in developing a science identity as a result of such disempowerment (Hazari, Sadler, & Sonnert, 2013).

These take-aways have had a significant influence in the selection of the study's purpose, research questions, as well as primary and secondary theoretical frameworks. The next section describes the primary and secondary theoretical frameworks that guide the study. The primary theoretical framework, Carlone and Johnson's (2007) model of science identity development, examines the STEM educational experiences of successful women of color in order to understand how these women develop a science identity within the higher education setting. The secondary theoretical framework of

intersectionality serves to highlight the intersections of multiple identities that may be present within the undergraduate Latina student participant. Together, these frameworks guide the study towards a greater understanding of STEM experiences and science identity development for Latinas at a tier-one predominantly white public research university.

Primary Theoretical Framework: Model of Science Identity

The study utilized Carlone and Johnson's (2007) model of science identity. Science education scholars traditionally pose three key arguments for utilizing identity as an analytic lens for educational settings. First, identity presents a new way of examining STEM teaching and the science learning environment (Carlone & Johnson, 2007). Cobb (2004) suggested that through this analytic identity lens, scholars could explore the type of individuals who are promoted and those who are marginalized as a result of normed science teaching and learning practices; examine the student perception of science education as a set of experiences, knowledge, and skills worthy (or unworthy) of their engagement; and understand the possibility that students' emerging science identities might eventually change the core identity of these students and who they seek to become.

Second, exploring identity development involves understanding student learning from the standpoint of individual socialization into the collective norms and discourse practices of the STEM fields (Brown, 2004; Kelly, 2007; Varelas, House & Wenzel, 2005). By examining the educational experiences and identity development of Latinas in STEM through an identity lens, one has the opportunity to explore the dynamic relationship between "individual agency as well as societal structures that constrain

individual possibilities" (Brickhouse, 2000, p. 286). These arguments are particularly significant for the investigation of how women of color are drawn to, pushed out of, and socialized into the White, masculine STEM culture (Carlone & Johnson, 2007).

Third, the analytic lens of identity enhances the pursuit for a more equitable science education. Carlone and Johnson (2007) state that enhancing science education requires scholars to pay "close attention to the kinds of people we ask students to become as they participate in science activities" (p. 1190), particularly women and students of color who may be asked to negotiate their existing identities. Traditionally, science practices may promote narrow science identities that may not appeal to a broad range of individuals and cause students to choose between embracing and resisting these narrow identities (Brickhouse & Potter, 2001; Carlone, 2003, 2004; Eisenhart & Finkel, 1998). For example, girls in traditional physics curriculum embraced the certainty of knowledge because it allowed them to earn good grades; however, they failed to develop science identities because the curriculum rejected scientific thinking, interactions, and tool use (Carlone, 2003). This level of knowledge and experience alone was not sufficient to sustain interest in the STEM fields, causing students to divert interests elsewhere.

Carlone and Johnson (2007) created the science identity model to examine the educational experiences of successful women of color throughout their undergraduate and graduate studies (see Figure 2). This science identity model explores how women of color constructed meaning from their science experiences and how larger society influences possible meanings. Their work is seminal to understanding science identity as an analytic lens for women of color (Latina, African American, American Indian, and

Asian American women) in higher education. In order to build the model, their work utilizes an ethnographic approach to understand the lived experiences of these women of color based on how gender and racial/ethnic identities affect their science identities. The model seeks to understand how successful women of color negotiate and make meaning of their science experiences, as well as how they develop and sustain their science identities throughout their undergraduate and early science careers. In addition, the model addresses the relationship between the women's science identities and their racial, ethnic, and gender identities. This model is relatively new but has gained traction recently as scholars have chosen to frame their work around a model which integrates science identity development with elements of race, ethnicity and gender (e.g., Lu, 2012; Herrera, Hurtado, Garcia, & Gasiewski, 2012).

The grounded model of science identity includes three overlapping key areas: science performance (performances of scientific practices, e.g., use of technical terms, tools), science competence (understanding of content), and science identity recognition (self- and outside recognition as a "science person"). This model was informed by Gee's theory of identity (1999, 2000) which puts forth the belief that "identity is, in part, informed by the 'kind of person' one is seeking to be and enact in the here and now" (Gee, 1999, p.13). In addition, rather than being self-decided, one's identity is the result of the participation of others. For someone to be "somebody," he or she must display competence and be recognized for his or her performance. As a function of these ideas, Carlone and Johnson (2007) suggest that: "One cannot pull off being a particular kind of person (enacting a particular identity) unless one makes visible to (*performs for*) others

one's *competence* in relevant paractices, and, in response, others *recognize* one's performance as credible" (p. 1190).

In this theory, the authors believe that women of color must be competent in their scientific knowledge and abilities as well as possess the confidence and required skills for demonstrating those skills in front of others. Finally, a woman of color must first recognize herself as a "science person" and then be recognized by others as someone contributing to the scientific community. The authors are primarily concerned with the third area, science identity recognition, and how racial, ethnic, and gender identities influence the way in which this particular identity is developed.

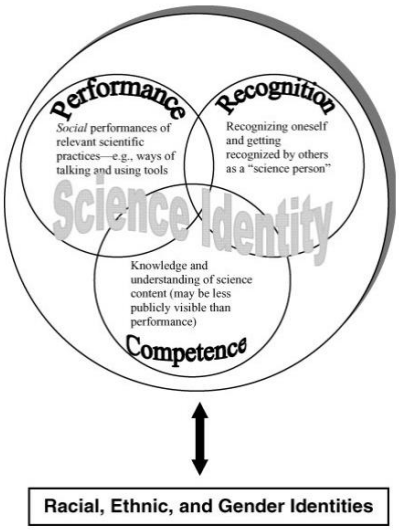

Figure 2. Carlone and Johnson's (2007) Model of Science Identity

Although the model provides a more thorough understanding of how women of color negotiate their experiences and construct a science identity, it does little to address

how specific areas of identity interplay with one another and further impact subgroups of women of color. In addition, the model could be strengthened by introducing elements of intersectionality in order to more fully develop the influence of race/ethnicity and gender on Latina Science identity development. Further exploration of how this model relates to the educational experiences and science identity development of each subgroup, especially Latina STEM students, is critical to creating a more nuanced understanding of women of color's experiences. Doing so may reveal differences in how Latinas negotiate and perform their science identities and how Latinas attribute value to self versus external recognition of their science identity. Encouraging a more in-depth intersectional approach to identity development will provide even greater understanding of where those identity intersections lie and how intersectionality affects identity development for Latinas in STEM.

Secondary Theoretical Framework: Intersectionality

In addition to the embedded intersectional nature of the science identity modeled (Carlone & Johnson, 2007), a secondary theoretical framework of intersectionality allows the researcher to capture the unique intersections of gender, race, ethnicity and other identities, which are present. Utilizing this approach, I would examine the dynamic interplay of race, class, and gender inequality affecting the Latina STEM higher education pipeline to college graduation. Intersectionality, like other critical lenses, places importance on the concept of interdisciplinary work and situating knowledge claims within the history and social context (Crenshaw, 1991; Hancock, 2007; Haraway, 1988). An intersectional analysis would argue that although race, class, and gender are

analytically distinct structures of inequality, they intersect and are equally important for understanding the Latina STEM higher education pipeline to college graduation.

Intersectionality is grounded by three principles: the historical context and patterns of oppression, the nature of varying experiences based on socially constructed categories of individuals, and the simultaneous interactions of multiple identities within an individual. The first principle suggests that "historical patterns of oppression, such as racism, sexism, homophobia, do not act independently of one another; rather these forms of oppression are interrelated and bound together by an intersectional system of discrimination" (Collins, 2000, p. 42). The second principle argues that individuals within the same socially constructed category (e.g. Latina) may not necessarily have similar experiences within a given context (Crenshaw, 1991; Collins, 2000) due to other aspects of her identity such as race, class, and sexual orientation. Finally, the third principle of intersectionality suggests that various elements of a person's identity may interact with each other simultaneously, thus making comparisons across categories more valuable than looking solely at categories separately (Berger & Guidroz, 2009).

Conclusion

The existing literature illuminates the need for further investigation of Latinas in the STEM college pipeline. While prior research has focused broadly on Latina/os and women of color in STEM, little scholarly research specifically examines the educational experiences and identity development of Latinas in STEM, especially as it relates to the unique challenges of highly competitive postsecondary settings. Existing literature provides only a broad understanding of these challenges. What is needed is a thorough

exploration of how Latinas who persist in their STEM majors make meaning of their experiences and how that meaning shapes their identity development, further impacting Latina education and career potential in STEM fields. In addition, much of the prior research fails to address the nature of intersectional identities, thus limiting our understanding of how an individual's multiple identities may intersect and affect identity development. As a result, the study seeks to contribute to the gap in the literature by examining Latina STEM educational experiences through a science identity framework for women of color, emphasizing the connections of science identity, race/ethnicity, and gender, as well as an intersectionality framework focusing on the dynamic nature of intersecting identities.

Chapter 3: Methodology

This chapter describes the phenomenological qualitative approach used to study the STEM experiences and science identity development of undergraduate Latinas who are persisting in their STEM major at a tier-one, predominantly white, public research university. The purpose of the study was to gain an in-depth understanding of how successful Latina college students develop and make meaning of their science identities. This research, framed by Carlone and Johnson's (2007) model of science identity, also explored the relationships between science identity and other intersectional identities that may be present. This approach allowed the dynamic interplay of race, class, and gender identities mediating the Latina STEM higher education pipeline to college graduation. This chapter highlights the research design of the phenomenological study, examines its participants, and describes the methods employed to examine three research questions:

1. How do Latinas develop and sustain their science identities during their college experience?
2. How do they make meaning of their formal and informal STEM experiences?
3. What is the relationship between science identity and other identities (e.g., gender identity, racial identity, socio-economic status identity)?

Research questions one and two primarily focus on the science identity development of Latinas during undergraduate years at a tier-one, predominantly white public research university. The first question seeks to understand the meanings that Latinas attach to their undergraduate STEM major experiences while the second question explores how Latinas

in STEM majors develop their science identities. The final research question seeks to understand the relationship between the development of Latina's science identity and possible other identities that may be salient to her experience. Using an intersectional approach allowed me to consider science identity and its intersections with race, ethnicity, gender, or other identities, in order to understand how the development of science identity is mediated by the presence of these identities.

This chapter introduces a detailed overview of the research design and methodology for understanding science identity development for Latinas during the undergraduate experience at a tier –one, predominantly White, public research university. First, the chapter examines the analytical paradigm and research design that framed the study and provides information related to the phenomenological approach and research questions (Figure 3). Second, the chapter examines data collection and analysis methods (Figure 4 and 5) and explores the validity, reliability, credibility, and transferability of the study. Third, the chapter presents information related to researcher positionality, researcher bias, limitations and delimitations which frame the study.

Interpretivism

The purpose of the study was to gain an in-depth understanding of how successful Latina college students develop and make meaning of their science identities. The study used an interpretivist epistemological approach to explore how it is possible that we learn about the world around us. Interpretivism, a form of social science research emerging from the work of German philosopher Immanual Kant, is accompanied by the ontological belief which:

> …portrays a world in which reality is socially constructed, complex, and ever changing. What is of importance to know, then, is how people interpret and make meaning of some object, event, action, perception, etc. (Glesne, 2011, p. 8)

This paradigm holds that there is no objective knowledge and that reality is socially constructed and embedded within the human mind (Glesne, 2011; Grbich, 2007). In the interpretivist paradigm, it assumes that multiple realities are present, with "different people experiencing these realities differently," and that knowledge would be plural, complex, and emerge as a result of a search for patterns (Grbich, p. 8). This study, therefore, is rooted in the belief that knowledge is gained from contextualization and understanding through interpretation (Glesne, 2011).

The study was strengthened by operating within this interpretivist paradigm that primarily focused on contextualization, understanding, and subsequent interpretation (Glesne, 2011). Because the study focused on *how* Latinas in STEM created meanings of their STEM major experiences and *how* Latinas developed science identities, the interpretivist paradigm was a natural fit that not only addresses the socially constructed nature of experience and identity development but also emphasized the importance of *how* Latinas make meanings of their experiences and identities through complex processes. Specifically, the nature of interpretivism to explore the way individuals understood and made sense of their experiences (Grbich, 2007), aligned clearly with the research purpose of this study.

Finally, through an interpretivist approach, the study was also grounded in the belief that both I and the social world have an impact on each other and that my findings are invariably influenced by these perspective and values (Grbich, 2007). The

subjectivity of my own socially constructed views as well as the intersubjectivity that exists when I attempted to reconstruct views as a result of interactions with others, are particularly important to understanding the nature of the interpretivist paradigm. Therefore, this research study acknowledges that layers of interpretation exist throughout the research process, not only through the individual meaning constructions of Latina undergraduate student participants, but also through the meaning constructions and interpretations of the researcher.

Research Design

To examine the complex processes associated with science identity development, a qualitative approach offers the ability to gain rich descriptions of Latina STEM student perceptions as well as explore the meanings and interpretations given to specific decisions, events, and ideas leading to science identity development (Miles & Huberman, 1994). This approach illuminated these processes as they unfolded and views Latina STEM students undergoing these processes as active participants in their STEM experiences (Gubrium & Holstein, 1997). Because qualitative research is grounded in experience, it emphasizes meaning and allows for a more in-depth understanding of human the behaviors of Latinas majoring in the STEM disciplines and the reasons that govern such behavior (Denzin, 2013). Qualitative research also allows for the investigation of the *why* and *how* of decision making while also enabling qualitative researchers to "stress the socially constructed nature of reality, the intimate relationship between the research and what is studied, and the situational constraints that shape inquiry" (Denzin, 2013, p. 23).

Furthermore, the qualitative approach helps the researcher to build connections within the data by uncovering:

> how these [data] are put together, more or less coherently and consciously, into frameworks that make sense of their experiences, and it illuminates the motivations that connect attitudes and behaviour, the discontinuities, or even contradictions, between attitudes and behaviour, or how conflicting attitudes and motivations are resolved and particular choices are made. (Hakim, 2000, p. 34).

At its core, qualitative research seeks to utilize interpretive practices to both illuminate the unexplored world and "to make sense of, or to interpret, phenomena in terms of the meanings people bring to them" (Denzin & Lincoln, 2000, p. 3). In this study, answering the research questions may involve linking a variety of seemingly unrelated factors associated with a particular STEM context or set of circumstances within the STEM experience. Attention to contextual and circumstantial detail allowed me to give special consideration to particular aspects of the STEM experience that quantitative approaches may typically overlook (Gubrium & Holstein, 1997). This opportunity for in-depth analysis of how certain factors and their context affect outcomes is one of the greatest strengths of qualitative research (Hakim, 2000).

Within a qualitative research approach, this study utilized a phenomenological approach to explore the lived undergraduate experiences of Latinas in STEM disciplines at a tier-one predominantly white public research university (Creswell, 1998). Phenomenology is situated within a paradigm of personal perspective and subjectivity, making its application to this research study's focus on making meaning and identity development suitable (Grbich, 2007). More specifically, the phenomenological approach illuminates how Latinas who are persisting within their STEM majors make meaning of

their experiences while engaged in higher education as well as how they perceive their individual science identity development over time (Willis, 2007). This approach is particularly effective at documenting changes in feelings and experiences, in depth and over time, for particular phenomena which need to be explored, described, communicated, and interpreted (Grbich, 2007). Given the study's nature of examining collected STEM experiences and the belief that science identity is an aspect of one's life that unfolds over time, this approach allowed me to examine STEM experiences and identity development within those parameters.

Phenomenology allowed for exploring experiences in depth and providing rich detail of the "essence" of an individual's experiences with a particular phenomenon" (Grbich, 2007, p. 84). Therefore, taking a phenomenological approach to research implies not only understanding the "essence" of experiences regarding a particular phenomenon (Creswell, 1998, p. 65), but considering the hidden meanings and how participants make sense of these experiences (Grbich, 2007). Unlike other approaches, the focus of a phenomenological study is not primarily on the life of the individual, but rather on an understanding of a concept or phenomenon (Creswell, 1998). Because phenomenology focuses on the lived experiences of social and psychological phenomena shared by participants, this approach allowed the research study to focus on the shared phenomena of science identity development during the undergraduate experience at a public tier-one, predominantly white, public research university (Moustakas, 1994).

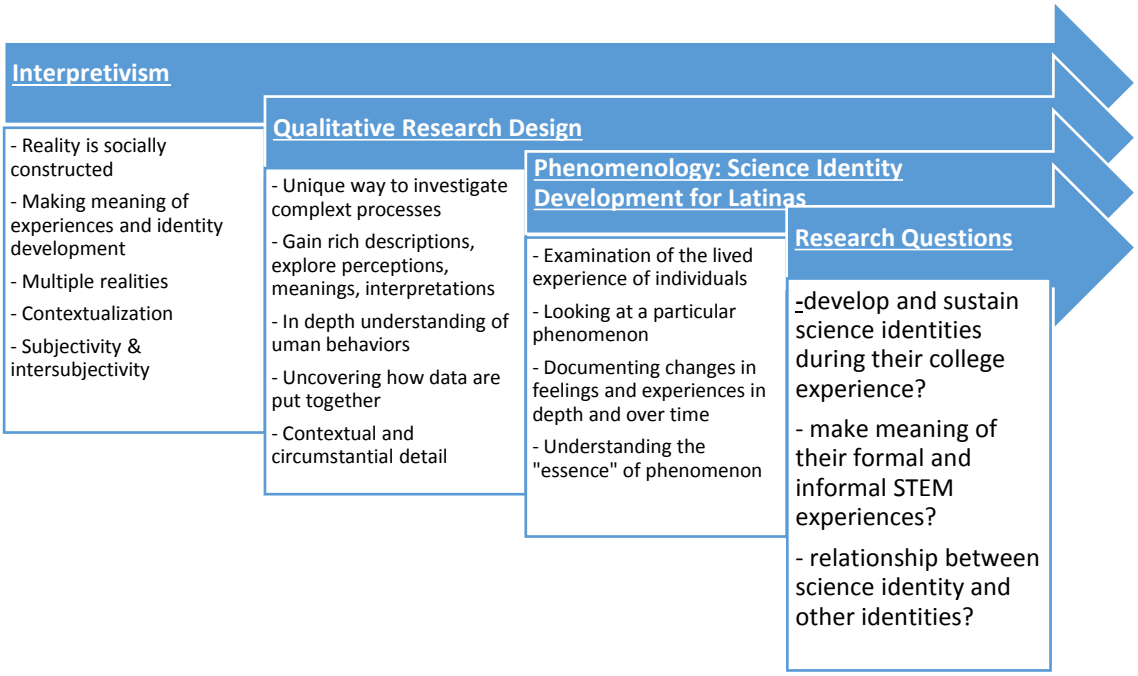

Figure 3. Overview of Interpretivism, Research Design, Phenomenological Approach, and Research Questions

Site Selection

This study was conducted at The University of Texas at Austin (UT-Austin), a public, tier-one, predominantly white, public research university in an urban city in Texas. According to the Carnegie Foundation for the Advancement of Teaching (2013), this institution is a Public Tier One Research (PTOR) institution with very high research activity and a competitive admissions process. In the semester of fall 2013, the institution enrolled 39,979 undergraduate students and 12,080 graduate students (Office of Information Management and Analysis, 2013). In total, the university had over 50,000 undergraduate and graduate students. The gender breakdown for the total student

population was female 50.7%, male 49.3%. The racial/ethnic background breakdown for the total student population showed White 48%, Hispanic (any combination), 19.1% Asian (only) 15.4%, 9 Foreign.2%, Black (only) 4.0%, and Other 4%. The demographic breakdown of the undergraduate population at the institution was White 47.7%, Hispanic 21.7%, Black 4.9%, Asian 17.8%, American Indian 0.2%, Hawaiian/Pacific Islander 0.1%. The institution enrolled 5,301 Hispanic undergraduate and graduate women and 4,619 Hispanic undergraduate and graduate women. These figures were an increase of 0.7% over fall 2012, with Hispanic students representing the largest increase of all minority ethnic/racial groups (Office of Information Management and Analysis, 2013). Over the past 10 years, students identifying as Hispanic at the institution has increased by 6.4%. Four year-graduation rate for the fall 2009 cohort is 52.0%, while the six-year graduation rate for the fall 2007 cohort is 79.4%.

According to the Office of Admissions (2014), the university's College of Natural Sciences and the College of Engineering combined (which account for most STEM degrees on campus), admitted slightly fewer Hispanic females as compared to their Hispanic male counterparts. Fewer Hispanic females were admitted in 2014, the lowest in three years, but this number was trending similar to other groups. There were almost twice as many White women admitted into these STEM areas as compared to Hispanic women and the majority of students (combined CNS and ENG) parents made $100,000+ combined income. In the College of Engineering, more White and Asian women were admitted than Hispanic women and more than twice as many Hispanic males entered engineering in comparison to Hispanic women. Overall, in past three years, almost four

times as many White students were admitted in comparison to Hispanic students. Within the College of Natural Sciences, more White and Asian women were admitted than Hispanic women. However, there were more Hispanic females than males. Overall, for the College of Natural Sciences, there was a more balanced race/ethnicity breakdown than the College of Engineering.

Patton (2002) advises researchers to think critically about research site selection and select a location that enables one to thoroughly answer the proposed research questions with a rich data source. This institution, therefore, was an ideal site for the study for three major reasons: (1) the demographic realities of the institution as well as the state of Texas, (2) the unique institutional profile of a public tier-one research university, and (3) the federal, state, and institutional imperative around STEM student success.

First, the demographic realities of the institution as well as the state of Texas demonstrate that more research and resources would need to be directed towards understanding and serving the growing Hispanic population. The institution had an ever-increasing Hispanic enrollment; however, enrollment figures did not ensure that degrees are conferred. In order to meet the needs of the growing Hispanic student population, the institution needed to understand their college experience and development. In broader terms, Texas had the second largest Hispanic population of any state in the United States which makes the potential for more institutions, such as this one, to become an Hispanic Serving Institutions (HSIs) a clear reality of the near future (Office of Information Management and Analysis, 2011; U. S. Census, 2011). Shifting demographics of the state

will force institutions in the state to focus on the needs of growing Latina/o population in order to enhance graduation rates. Looking at Latina Science identity development in these changing demographic conditions provides valuable insight on what is needed to enhance Latina STEM student success and identity development and ensure that more Latinas are engaged in the STEM pipeline.

Second, the institutional profile of a tier-one, predominantly white, public research university provides a very unique set of circumstances under which I may examine Latina STEM experiences and science identity development. The institution's size, research intensity, and predominantly white demographics establish an educational setting that is, in many instances, unfriendly to students of color. PWIs achieve lower levels of success in retaining and graduating students of color in STEM (Chang, Cerna, Han, & Saenz, 2008). Empirical evidence suggests three major findings related to the effects of institutional environment on the success of students of color in STEM: (1) culture affects the educational experiences of racial minorities, (2) connecting to the contrasting cultures at PWIs and within STEM departments may be difficult because these cultures differ so much from their own, and (3) PWIs have the ability to create meaningful connections between campus and racial cultures and validating students' cultural backgrounds in a purposeful way (e.g. Harper & Hurtado, 2007; Museus, Nichols, & Lambert, 2008; Nora & Cabrera, 1996).

Furthermore, the fact that this institution is a public research university with high research intensity suggests that the educational pathway for women of color, especially in the STEM environment, may present additional challenges to transition and persistence.

Finally, the institution is the flagship of its system, which means that it serves as a symbol of leadership that shapes the way higher education is perceived in the state of Texas. Given the proximity of the university to the state's capitol building (merely blocks) and the status of the institution as the state's flagship institution, the institution influences educational policy at the state-wide level.

Third, the federal, state, and institutional imperatives around STEM student success allow this study a special opportunity in space and time. Federally, President Obama has set forth the call for more STEM majors to be produced and greater funding to be directed towards these initiatives. Across the nation, imperatives are encouraging K-12 and higher education policymakers, researchers, and administrators to focus on STEM development initiatives. Statewide, the Texas Higher Education Coordinating Board and the Texas Education Agency have thrust this issue into public discussion, especially as it relates to the economic well-being of our state and country's future. In addition, the university has in recent years sought to boost the number of STEM graduates while improving the quality of education for students. With one of the largest colleges of science in the country, the university has created a, "suite of innovative opportunities for undergraduate education and a robust, inquiry-based learning experience," including a mentor leadership academy and small learning communities (Laude, 2011).

Finally, from a pragmatic standpoint, I, as a member of the university community, had access to information, data, and participants that allow the study to be conducted in a timely and efficient manner.

Participant Selection

This study focused on the experiences of 16 undergraduate Latina who are persisting in their STEM majors at the selected research site. This study engaged in purposive sampling in which the selection of participants is criterion based (Patton, 2002). Participants must meet the following criteria: (a) be over the age of 18, (b) identify as Latina or Hispanic, (c) identify as female, (d) be classified as a college junior or senior, and (d) be currently enrolled as a science, technology, engineering, or math major.

The study centers upon the perspectives of Latina juniors and seniors in STEM because their persistence through the college experience will yield an enhanced understanding of the science identity development process across multiple years within the STEM discipline and at the research site. Participation is limited to the College of Natural Sciences or the College of Engineering as these colleges represent the largest numbers of STEM majors within the university. First-generation college student and immigration status are deliberately left open in order to facilitate participant recruitment of an already small population as well as capture a wide range of experiences from possible participants.

Institutional Review Board approval was obtained in order to commence the study and establish contact with potential participants. Recruitment of student participants was conducted in multiple ways. First, the study recruited student participants through existing professional relationships with administrators acting as "gatekeepers." Negotiating access through these gatekeepers was essential to connecting with Latinas in the STEM disciplines and ensuring the overall success of accessing participants for the

research study (Ritchie & Lewis, 2009). Recruitment was primarily conducted via email (via emails similar to those in Appendix A and Appendix B). Students were informed of the study through an email that I forwarded to professional contacts throughout the university that work with undergraduate students. University contacts forwarded the email to their respective listservs. Students interested in participating contacted me directly.

As a second approach to recruitment, then I reached out to STEM-related student organizations to recruit participants at events or meetings. I asked student leaders for a few minutes of time to introduce the research study, then those students who were interested in participation connected with me. This approach allowed me to access a different group of students who may or may not be connected to university gatekeepers. As a third approach to recruitment, I employed a snowball sampling technique in which participants will assist me to identify other participants who may meet the criteria of the study and whose experiences are information rich (Miles and Huberman, 1994). Although it was anticipated that due to the specificity of the study's criteria (over 18, Latina/Hispanic, female, junior/senior, STEM major), there might be challenges to identifying participants, but these recruitment methods proved successful.

After students indicated via email that they would like to participate in the study, an initial interview time was scheduled with the student. Participants were required to sign an informed consent granting their permission to participant in the study. The informed consent form explained the purpose of the study, outlined the research procedure, and described the conditions of participation. Participation in the study was

completely voluntary. A discussion between the interviewer and the participant took place at that time, giving an overview of the study and outlining expectations for participation. The student had ample time and ability to ask questions and/or express any concerns that they may have had before signing. At that time, the student kept a copy of the consent form, including all of my contact information, and another copy went on file I maintained.

Data Collection

Data collection for this study focused on the STEM experiences and science identity development of undergraduate Latinas at a tier-one, predominantly white, public research university. This study used three methods for data collection (1) pre-interview questionnaire, (2) phenomenological semi-structured interview, and (3) focus group. The pre-interview questionnaire and consent form took place before the semi-structured interviews and focus groups (Figure 4).

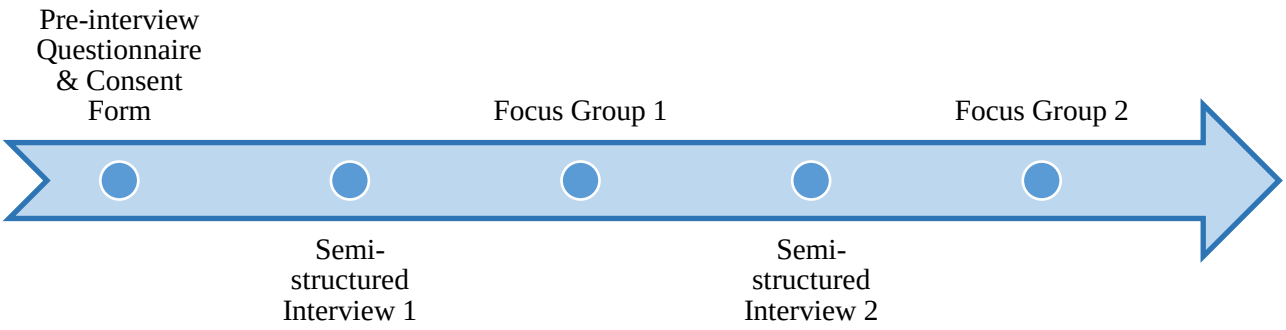

Figure 4. Data Collection Methods

Pre-interview Questionnaire. A pre-interview questionnaire (Appendix C) was administered to the Latina student participants prior to the interview to gather demographic and background information that was used in the interview and data analysis processes. The pre-interview protocol included name and contact information, as well as relevant demographic and background data of the student and her family. In addition, the questionnaire had items addressing STEM experiences at the institution, science identity development, as well as identifying influential people within their experiences and degree aspirations. The overall purpose of these items was to identify influencing factors that impacted STEM degree experiences and science identity development. Data received from the pre-interview questionnaire enabled me to create an accurate student participant profile for the group as well as be able to tease out aspects of a student's experience.

Semi-structured Interviews. Using Seidman's (2006) model for conducting phenomenological, individual in-depth interviews, this study included the perspectives of 16 Latina undergraduate STEM majors. Individual interviews allowed me to delve more deeply into the participant's experience and clarify issues that are unclear to the researcher (Ritchie & Lewis, 2009). Furthermore, these interviews encouraged an "undiluted" focus on the participant and are uniquely suited for "research that requires an understanding of deeply rooted or delicate phenomena" (Ritchie & Lewis, 2009), making their placement within this in-depth phenomenological study of undergraduate Latinas in STEM at a tier-one, predominantly white public research university appropriate.

Each of the 16 participants completed two individual, semi-structured interviews regarding their STEM experiences and science identity development, for a total of 32 interviews. Interviews took place during the spring 2014 semester. Interviews used semi-structured interview protocols to direct the interviews towards certain topic areas but allow flexibility, as needed (Miles and Huberman, 1994). Probes were used throughout the interview process to ensure that complex processes or ideas are explored to a greater depth (Ritchie & Lewis, 2009). Amplificatory (encouraging elaboration), explanatory (exploring reasoning), and clarificatory (explaining details or language) probes were used to deepen the level of conversation and solicit a greater depth of knowledge of the experiences and identity development for Latinas in STEM (Ritchie & Lewis, 2009).

For the first interview, the protocol included questions that explored STEM experiences and identity development as well as allowed me to build rapport with students and make students feel more comfortable during the interview process

(Appendix D). Building rapport involved building confidence within research participants and, ultimately, moving towards a sense of trust within the researcher/participant relationship (Glesne, 2011). To establish trust within the researcher/participant relationship confirmed a sense of honesty and integrity within the interview process and facilitated the interview process for research participants (Glesne, 2011). The remaining questions in the interview protocol drew from prior research of science identity and women of color (as seen in Chapter 2). These questions examined a range of topics, including: Latina interest in the STEM disciplines, Latina experiences within the STEM disciplines, and finally, provide recommendations for Latina Science identity development to students and university administrators.

In the second set of interviews, students answered follow-up questions from the previous interview, engaged in an artifact discussion, and discussed identity development experiences (Appendix E). The initial questions were tailored to each participant in order to provide greater understanding of their science identity development. Therefore, the second set of interview questions served as a type of checking for understanding as well as a means to further examine emerging themes. Additional questions on the semi-structured interview protocol were targeted questions drawn from prior research (as seen in Chapter 2) related to emerging Latina STEM experiences and science identity development.

The second interview included an artifact discussion during which Latina STEM students provided five artifacts that demonstrated aspects of their identity. An "artifact" describes a variety of material objects, which represented or gave meaning to the culture

and people that one is studying (Glesne, 2011). Asking participants to produce artifacts enabled me the opportunity to "read" those artifacts and discover the meanings attached to such objects by the participant (Glesne, 2011). With me, students identified and described the artifacts that they brought to the interview and elaborated on how those artifacts related to their science identity as well as any other intersecting identities. I documented (via photograph, observations) each artifact that the participant identified and stored documentation for later analysis.

Following the artifact discussion, students answered questions related to STEM competence and identity recognition. Throughout the interview process, which was informed by the study's theoretical framework, students were encouraged to expand the conversation and address any other information that they felt was relevant to their experience. Interviews were conducted face-to-face at a mutually agreed upon location. Interviews lasted approximately one hour and were digitally recorded and transcribed verbatim for later analysis. Throughout both sets of interviews, I took field notes on the content of the interview, non-verbal cues, and overall disposition of my participants. One-page summaries were created after each interview that detailed significant information about the student and identified major themes discussed. These one-page summaries facilitated data analysis and the examination of major themes across all participants.

Focus Groups. The study was supported by two focus groups of Latina STEM undergraduate student participants who were previously interviewed in the study. The phenomenological study employed the focus group approach in order to explore the

Latina STEM experience and science identity development in greater depth and maximize efficient use of time, as this approach allows access to the perspectives of a number of Latinas in STEM at the same time (Glesne, 2011). Although not traditionally part of a phenomenological approach, I believe the focus group method is compatible with phenomenology. Giorgi's (2000) work indicates that "bracketing" in phenomenology occurs through the researcher, rather than the participant, challenging the assumption for separation in the data collection phase (Bradbury-Jones, Sambrook, & Irvine, 2009). Bradbury-Jones and colleagues (2009) posit that phenomenologists Halling and Leifer (1991), Halling, Kuntz, and Rowe (1994) and Spiegelberg (1975) demonstrate the link between focus groups and phenomenology, leading researchers to believe that the use of focus groups within phenomenology "might actually be advantageous" (p. 667).

All of the study's participants were invited to participate in focus groups, but no more than eight participated at one time. Focus groups supported the data collection process by providing:

> a social context for research, and thus an opportunity to explore how people think and talk about a topic, how their ideas are shaped, generated or moderated through conversation with others. (Ritchie & Lewis, 2009).

The focus group allowed Latina STEM undergraduate students the opportunity for reflection on their STEM experiences as well as provided a space for refining those experiences based on the responses of other focus group participants (Ritchie & Lewis, 2009). Utilizing a meaningful set of protocol questions and skills as a discussion facilitator, the focus group explored new areas of interest and deepened participant insight on their own thoughts and actions (Glesne, 2011; Ritchie & Lewis, 2009).

Each focus group lasted around an hour and a half and was digitally recorded and transcribed for later review. Both focus groups had a brief semi-structured protocol with questions relating to the development of science identity at a tier-one, predominantly white, public research university for Latinas. The overarching goal for both focus groups was to explore major findings from other data collection methods and to gather additional context for these findings and either reinforce or refute these findings. Focus group one took place after interview one in the data collection process. The specific goals for focus group one were to: (a) examine STEM classroom and informal academic experiences throughout their college career, (b) explore participant perspectives on STEM achievements and challenges, (b) examine science identity development and explore intersectional identity influences (Appendix F). Focus group two took place after interview one in the data collection process. The specific goals for focus group two were to: (a) explore sustained student participant interest in STEM, (b) discover meanings Latina STEM students attach to STEM achievement and science identity recognition, (c) examine future STEM plans and aspirations, and (d) gather suggestions on how higher education administrators, faculty, and staff could better serve the identity development of Latinas in STEM through classroom-based strategies, and institutional services and policies (Appendix G).

Data Confidentiality and Anonymity

The qualitative data were collected and coded to protect anonymity at the individual level. All names were removed and in order to further protect the identities of the participants. Each student was assigned a pseudonym (primarily for identifying and

maintaining files) so that their name is not clearly connected to any of the information that they reveal (Creswell, 2013). Any information that was obtained in connection with this study and that can be identified with students will remain confidential and will be disclosed only with student permission or as required by law. Any publications as a result of this research will be scrutinized to prevent any disclosure of potentially identifiable information.

Participants were asked to give truthful responses to the questions, despite any positive or negative portrayal of the institution or its STEM programs and/or faculty and staff. The highest level of confidentiality was exercised during this research as well as professionalism on the part of the principal investigator regarding any data that were gathered during the study. Students were made aware before start of study that any information or extreme cases of danger to self/other students deemed to be outside the traditional terms of confidentiality would be reported to the proper officials. However, in order to still encourage participants to respond truthfully, each student was given a pseudonym to protect their identities and, therefore, their opinions and reflections of their experiences.

I used a master file in which the participant's real name and the assigned pseudonyms were listed. This master file was securely stored so that it was kept separate from the consent forms and collected data. The file was stored in a separate cabinet from the other data and was destroyed upon the completion of the study. Confidentiality was maintained by means of all data being stored within a secure filing cabinet in the private dwelling of the principal investigator. All electronic data were stored on a password-

protected computer. Only I had access to the digital audio recordings and transcription data. Hard copy and electronic data were retained for 3 years in this locked cabinet in my office and on a password-protected computer, respectively. Consent forms will be securely stored in a locked cabinet in my office – one that is not connected to other study data in order to avoid data association. These forms will be kept for 3 years after the study is completed in a de-identified form – meaning that identifying information has been removed and the master key file has been destroyed.

Phenomenological Data Analysis

The study used Creswell's (2013) phenomenological analysis and representation approach to guide the exploration of the data and produce the study's findings. Creswell's (2013) approach to phenomenological analysis represents a simplified version of one of the approaches outlined by Moustakas (1994), which had been informed previously by the Stevisk-Colaizzi-Keen method. The analysis process (see Figure 5) was divided into six recursive areas: (1) data organization, (2) reading and memoing, (3) describing the data into codes and themes, (4) classifying the data into codes and themes, (5) interpreting the data, and (6) representing and visualizing the data.

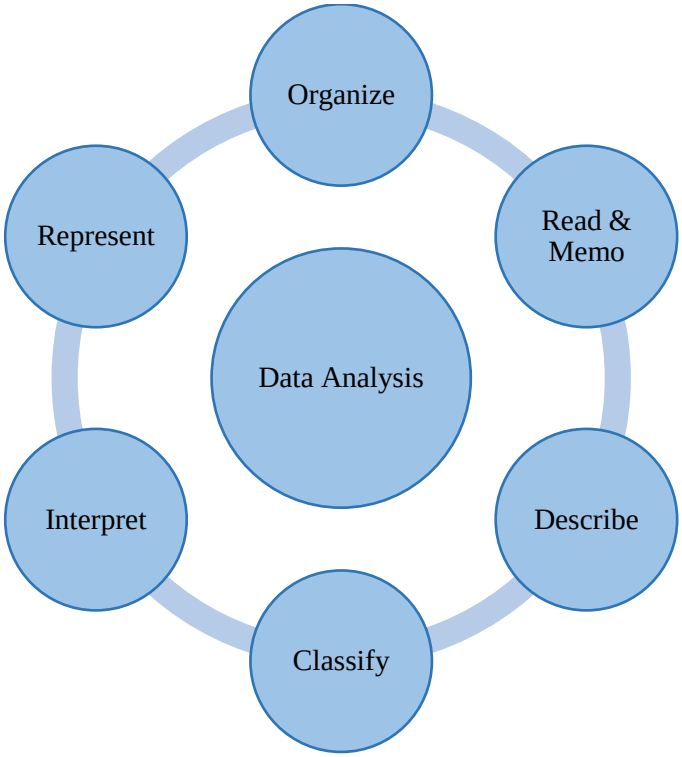

Figure 5. Phenomenological Data Analysis

Data Organization. The goal of this phase of analysis was to take the large volume of information that was collected and organize it into a format that facilitated analysis. All field notes and digitally recorded interviews and focus groups were transcribed verbatim and de-identified (and pseudonym-labeled) to protect the identities of participants. Then, in order to make the data more accessible for analysis, individual folders were created for each participant. Each pseudonym-labeled participant folder contained all relevant information for that participant, including interview transcripts, field notes, memos etc. Folders for focus group transcripts, interview and focus group protocol questions, and any remaining field notes or memos were filed separately, as

needed. Once all data were organized into individual folders, the content of each student's folder was uploaded into Atlas.ti, a computer assisted qualitative analysis software platform, to prepare for data analysis.

Reading and Memoing. The goal of this phase of analysis was to gain an overall sense the data set by reading through the collected information, making margin notes, and forming initial codes. Reading through the collected information allows me to review the data that has been collected but also allows me to begin understanding each participant's experience in more detail and start drawing connections between the data. Memoing in the form of margin notes allowed me to capture initial perspectives on the data as well as pose possible patterns or additional questions (Saldaña, 2009). In addition, within this step, I formed initial codes, informed by the theoretical framework as well as the student's experiences that guided analysis.

Describing the Data into Codes and Themes. The purpose of this step in the analysis process was two-fold. First, I described her experience of this research study through the use of "epoche" in which I provided a full description of her experience of the phenomenon, in this case, the STEM experiences and science identity development of undergraduate Latinas in STEM at a tier-one predominantly white public research university (Creswell, 2013, p. 193). Creswell described this process as a way in which the researcher attempts to set aside personal experience in order to focus on the study's participants (Creswell, 2013). From this point, I then described the context and "essence" of the phenomenon, highlighting what I felt to be the most important aspects of the phenomenon experienced by the research participants (Creswell, 2013, p. 116). Capturing

the most important aspects of the experience, as seen by the researcher, can provide an opportunity to contrast these descriptions with those of the research participants, thus addition an additional dimension of understanding.

Classifying the Data in Codes and Themes. The purpose of this data analysis step was to develop significant statements then group those statements into meaning units. I utilized data collected to find significant statements that highlighted individual experiences of the phenomenon. Once the significant statements are identified, I created a list of these experiences, taking care to assign equal worth to all statements. From there, significant statements were grouped into larger "meaning units" or themes in order (Creswell, 2013, p. 193). This process allowed me to identify the meaningful experiences of the research participants and discover emerging themes within the data set.

Interpreting the Data. The goals of this step of the analysis process were to examine the series of events in the phenomenon being studied as well as look at how that phenomenon was experienced by both the student participants as well as the researcher. First, I described the series of events, or the textural description of "what" happened, for the participants. These descriptions included both my interpretations of the information that was related as well as the verbatim examples that the participants supplied. Next I assembled a structural description of "how" the phenomenon happened, taking in to consideration context and setting of the events related by the participant. Finally, this step required me to combine both the textural and structural descriptions in order to form the "essence" of the phenomenon. Creswell (2013) described this section as what is the

"essence" of the student's experience that "represents the culminating aspect of a phenomenological study" (p. 194).

Representing and Visualizing the Data. The goal of this step within this analysis process was to present a description of the "essence" of the experience in an easily understood format. This step utilized discussion as well as tables and figures to describe the findings of the research study and illuminated the lived experiences of the research participants. These representations are including in the findings chapters of this work (Chapters 4-6). Chapter four presents short qualitative vignettes of the students' experiences and provides a profile of all participants. Chapter five and six present qualitative data in the form of quotations and relevant text as well as tables intended to help visualize the overall findings of the study.

Establishing Trustworthiness

Establishing the trustworthiness for this qualitative research study meant building supports within the study that ensure the accuracy of my understandings and subsequent findings. Creswell (2013) called upon researchers to, "look to themselves, to the participants, and to the readers. There are multi- or polyvocal discourses at work here that provide insight into the validation and evaluation of a qualitative narrative" (p. 243). To validate qualitative research, Lincoln and Guba (1985) refer to a series of "naturalist's equivalents" which seek to establish credibility, transferability, dependability, and confirmability of the study (p. 300). *Credibility* establishes that qualitative research results are believable from the perspective of the research participant. *Transferability* relates to the ability of the qualitative research findings to be generalized or transferred to

other research contexts. *Dependability* emphasizes context-dependent nature of qualitative research and calls upon the researcher to explore the research setting and its effects on the participants and their experiences. *Confirmability* focuses on the degree to which other researchers could effectively confirm similar findings to the present research study. In order to ensure the trustworthiness of this research study, six major techniques will be employed: (1) prolonged engagement, (2) rich, thick description, (3) triangulation, (4) member-checking, (5) peer-debrief, (6) clarifying researcher positionality and bias. These techniques sought to established credibility, transferability, dependability, and confirmability of the research study, as noted.

Prolonged Engagement. Prolonged engagement enabled me to build trust with student participants, learn the various norms around STEM culture, and check for understanding (Merriam, 2009). Prolonged engagement for this study came through the semester-long data collection phase of the project and the continued interaction between researcher and participants in the form of member-checking follow-ups conducted after the main data collection period. Prolonged engagement was enhanced by multiple interactions with each of the participants in multiple settings; both formal and informal Additional time was spent in casual conversation in an effort to build rapport.

Building trust with student participants, as discussed earlier, built a sense of rapport between researcher and participant, thus creating a better context in which I could build trust and explore the science identity development experiences of Latinas in STEM at the university. Learning the norms around STEM culture, particularly as they relate to participant actions and interactions with various stakeholders in the STEM culture (i.e.

peers, faculty members, tutors, advisors), illuminated their lived experience in greater detail and provided context for the interviews and focus groups. Finally, prolonged engagement provided a multitude of opportunities over an extended time period for me to check for understanding with participants and clarify any points of confusion or misinformation that arose through the research process. These processes allowed me to explore the transferability of the findings to other possible contexts and the degree of dependability that the findings had on the given research context.

Rich, Thick Description. Rich, thick description involvd the researcher describing in detail the study's participants and/or setting (Creswell, 2013). Detailed description was used to provide "abundant, interconnected details" (Stake, 2010, p. 49) which illuminated a variety of aspects such descriptions or activity processes. These rich, thick descriptions allowed readers to more fully understand the research participants and assess the transferability of the study's findings to be generalized or transferred to another research context. In chapter four, vignettes provide rich description of pre-college and college STEM experiences in order to understand the context of each Latina's lived experience. Chapter five and six utilize rich, thick description to illuminate the key elements of science identity development for these Latinas in STEM disciplines and explore the intersectional nature of that development.

Triangulation. The process of triangulation involved comparing evidence from different sources, particularly from different data types, to shed light on the theme or perspective (Miles and Huberman, 1994). When qualitative researchers "locate evidence to document a code or theme in multiple sources of data, they are triangulating

information and providing validity to their findings" (Creswell, 2013, p. 251). This study triangulated by comparing items from pre-interview questionnaires, interviews, and focus group transcripts. The questionnaire approached triangulation from a written response while the interviews and focus groups approached triangulation from the spoken word from one-on-one interviews and the multi-individual setting of the focus group. By using multiple types of data, I was able to more fully understand the context of the research study and analyze data for inconsistencies. Data collected which pointed to similar findings and conclusions increased the likelihood of accuracy and validity to the study and provided a better understanding of the science identity development of the Latina participants.

Member Checking. Member checking involved verifying the study's findings and interpretations with the research participants (Miles & Huberman, 1994). Lincoln and Guba (1985) suggested that member checking was the most critical step for establishing trustworthiness. Member checking allowed participants the opportunity to confirm the accuracy of the information captured during the interview (Creswell, 2013; Miles & Huberman, 1994). Member checking helped ensure accuracy of the study's facts before engaging in analysis.

By utilizing multiple procedures of data gathering, I reduced the likelihood of misinterpretation and allowed greater trustworthiness within the study. This study employed four types of member checking within the research study. First, I employed a type of internal member-checking within the sequence of interviews by asking follow-up questions to clarify points of confusion or seek elaboration.

Second, I employed member-checking through the use of a focus group after each round of interviews. In the focus group, I had the opportunity to pose possible findings and interpretations, and then participants responded by affirming, refuting, or extending the understanding that I had built throughout the study. Third, I employed member-checking through the sharing of initial written vignettes to participants. Each participant was given a copy of their personal vignette to ensure that I had portrayed their experience effectively and open the opportunity for revision or discussion. Several of the participants responded by affirming or modifying their vignettes and returning them to me. Fourth, I employed member-checking through the presentation of findings at an event open to participants as well as the general university population. Participants were invited in advance to this event and encouraged to ask questions and comment on the findings, as they desired. One-fourth of the study's participants engaged in this event and offered feedback for the study. Member checking builds the credibility and confirmability of the research study by reinforcing the believability of findings and demonstrating that those findings could be confirmed by other researchers.

Peer Debrief. This process required me to discuss data and findings with peers (Lincoln & Guba, 1985). The peer debriefer served as "an individual who is both willing and able to ask the difficult questions about methods, meanings, and interpretations as well as help ensure that the researcher is honest about the study's findings" (Creswell, 2013, p. 251). Peer debriefing allowed an external view of the research process and providesd the opportunity to receive additional perspectives on the study's methodology and findings. In addition, peer debriefing also allowed me to explore other

interpretations of the data. The group of peer de-briefers consisted of three higher education graduate students, one clinical faculty member in higher education, and one STEM graduate student. Peer de-briefers understood the goals of the study and were used as a sounding board at all stages of the research process. Peer debriefers posed questions, explored conclusions, and speculated possible themes at each stage of the research.

Positionality and Researcher Bias. Qualitative researchers need to "position" themselves in their writings; the researcher must be conscious of the biases, values, and experiences that he or she brings to a qualitative research study – this is known as reflexivity. According to Creswell, this concept of reflexivity requires that the inquirer make her "position" explicit (p. 216, Creswell, 2013). In order to explore one's positionality, it is important to engage in reflexive activities. Reflexivity has two components. First, I talked about her experiences with the phenomenon being explored. This involves past experiences through work, schooling, family dynamics, and so forth. Second, I then discussed how these past experiences shape my interpretation of the phenomenon.

In terms of positionality, I experienced both insider and outsider status in relationship to the research participants. I had an insider perspective, first, as a member of the campus community. Through this insider perspective, I was familiar with the general university norms, the characteristics of the student body, university processes as a whole, and the institution's high research intensity expectation for STEM students. In addition, I have had experience teaching first-year STEM students within a leadership and mentoring class setting at this university and am a Texas native. In addition, I had a

second insider perspective from the standpoint of both the researcher as well as the research participants identified as Latinas. Through this insider perspective, I was familiar with many of the cultural norms of the Latina/o community and felt included within this community. I am closely connected to the Rio Grande Valley area of Texas where many of the participants originate from and had a working knowledge of the Spanish language.

In contrast, I also held an outsider perspective based on the fact that she was not, nor has ever been, a STEM discipline major or worked in the STEM fields. She was not directly familiar with STEM cultural norms for gender or scientific performance and has experience only indirectly with STEM college experiences. In addition, I did not grow up within the Latina/o community, nor did she use Spanish as a first language, and was not of the Catholic faith (as many of her participants assumed she was).

Furthermore, my position at the university as an instructor, researcher, and Latina in a doctoral program influenced the way in which students interacted with her. For instance, students often assumed that she had a STEM background or that she worked in the STEM fields. Also, students often looked to her as the "expert" or assumed that she had inside STEM knowledge simply because she was the researcher and occupied a place of power within the relationship dynamic. Some students related that they were inspired by her work in this area while it seemed that others were intimidated by these various positions.

To possible reduce bias, the study used multiple trustworthiness techniques in order to acknowledge and explore researcher positionality in order to be as open and

receptive as possible while participants described their Latina science identity development at a tier-one, predominantly white, public research university (Moustakas, 1994). Throughout the research process, I examined how positionality and bias may have influenced interactions with participants, data that were collected, and interpretations that were made.

Limitations and Delimitations

The scope of this study was limited to examining the undergraduate science identity development process of Latinas who persist in STEM majors at a tier-one, predominantly white, public research university. First, this study was limited in scope by the sample size of 16 which, in one sense, allowed me to delve deeply into the lived experiences of these students, however, did not allow for the wide range of potential differences in the lived identity development experiences of Latinas in STEM disciplines at a tier-one, predominantly white, public research university. While the lived experiences of the participants within this study may not exactly represent the lived experiences of all Latinas in STEM disciplines, an effort was be made by myself to be as thorough as possible in selecting study participants whose experiences may be able to capture a wide range of understanding.

Second, the study's intentional selection of advanced undergraduate Latinas in STEM disciplines reflected delimitation meant to focus on the identity development experiences of students over time. Students early in their college careers were not selected as possible participants because I wanted to focus on the process of identity development for Latinas in STEM over the course of years, rather than months. By

seeing how this phenomenon has unfolded over time, I had a better opportunity of understanding how the science identity development process takes place for Latina students.

Finally, the purposeful decision to focus the study on a tier-one, predominantly white, public research university delimited the study to exclude other types of institutions, including, but not limited to community colleges, regional universities, Hispanic-serving institutions (HSIs), or historically Black colleges and universities (HBCUs), etc. Although information gathered from this study may add to the depth of knowledge regarding Latina Science identity development, particularly for Latinas at tier-one predominantly white public research universities, results may not generalize to other types of institutions.

Chapter 4: Student Vignettes

As previously indicated, the goal of chapters four, five, and six are to present data that answer my research questions. The research questions are: 1) How do Latinas develop and sustain their science identities during their college experience? 2) How do they make meaning of their formal and informal STEM experiences? 3) What is the relationship between science identity and other identities (e.g., gender identity, racial identity, socio-economic status identity)? Dividing the data into three chapters allowed me to focus each chapter on a particular purpose and explore the essence of a student's experiences in a more meaningful way.

This chapter provides vignettes of each of the study's participants, including key information related to pre-college and college STEM experiences. For chapter five, aimed at answering the first and second research questions, I utilized the study's primary theoretical framework related to science identity development (Carlone & Johnson, 2007). Utilizing this framework for analysis illuminated how these Latinas in STEM made meaning of their STEM experiences and developed their science identities. For chapter six, aimed at answering the third research question, utilized an intersectional framework to explore science identity development (Crenshaw, 1991). Utilizing this framework for analysis allowed me to explore how students made meaning of their STEM experiences and developed their science identities in terms of their multi-dimensional identities.

This chapter presents a brief vignette of each of the study's sixteen Latina participants (see overview in Figure 6). The purpose of these vignettes is to contextualize

and clarify the research study's findings as they are situated within the complex nature of life. Each vignette presents a brief introduction to the student, including pre-college and college experiences, and concludes with brief summary of the student's short- and long-term goals associated with their pursuit of the STEM fields. These vignettes have been adjusted in in some areas to protect the identities of the participants. This section concludes with a brief student profile of demographic information primarily from the student questionnaire that is intended to provide further context for the research study.

	Name	Classification	Major
1	Ana	Senior	Engineering
2	Ashley	Junior	Computer Science
3	Carmen	Junior	Mathematics
4	Cindy	Senior	Computer Science
5	Emily	Senior	Biology
6	Esperanza	Junior	Public Health
7	Isabel	Junior	Human Development & Family Sciences
8	Laris	Senior	Biochemistry
9	Lydia	Senior	Engineering
10	Maite	Junior	Biology
11	Maria	Senior	Biology
12	Salma	Junior	Nutrition
13	Samantha	Junior	Human Development & Family Sciences
14	Sofia	Senior	Engineering
15	Tatiana	Senior	Public Health
16	Victoria	Senior	Engineering

Figure 6. Student Participants, Classifications, and Majors

Ana

Ana was a senior engineering student at UT-Austin. Originally from Mexico, she ultimately decided to attend UT-Austin due to its academic reputation, extra-curricular

opportunities, and the increased possibility of future graduate school acceptance as a result of the rigorous curriculum. Ana explained that had she chosen to go to school in Mexico, it would have limited her opportunities, provided her no extra-curricular activities, and perhaps not encouraged her to pursue graduate school. Her older sister had previously done an educational exchange with UT-Austin and suggested that Ana apply here, so she was familiar with the institution in some ways. Ana had never traveled to Austin and didn't really know what to expect from the institution or its STEM programs.

At first, the language barrier and her lack of English language skills intimidated her, but once she became a residence life assistant, she was able to improve her language skills and feel a sense of community among her college peers. Being part of the residence life staff has shaped her college experience and it has been the reason that she's been able to continue attending the university. Her family could not afford to pay the increasingly expensive tuition, so she was forced to find other means – residence life staff were allowed housing and meal plan benefits that enabled her to pay less for her college experience. She enjoyed her position and the ability to help first-year students make connections at the university. She suggested that the residence hall staff acted as a fictive family, as they worked and lived together with each other.

Ana had enjoyed math and science before college and knew that she wanted to study engineering in college. High school teachers recognized her achievement in these areas and family members reinforced her math and science interests. Her pre-college teachers recognized that she was inclined towards math and science and was named "math student of the year." Her friends were generally surprised that she was in such a

"hard" major, however, she stated that anyone who really knows her was not that surprised. She had several engineers in both her immediate and extended family that served as role models to her, including her father. Ana suggested that her father was very influential in his role as an engineer, often bringing her and her sister along with him to work. When talking about her family, Ana emphasized that her family was very proud that she was attending college. They did not particularly push her in any direction, but they were proud that she pursuing a field that she enjoyed. Even though she was not physically able to be with her family due to her attending college in the U. S., she maintained that she served as a role model for the younger children in her family.

Ana's advice to incoming STEM students was to pursue their goals in science, even though it's rigorous – suggesting, if you enjoy it, do it. She admonished students not to give in to stereotypes and believed that there are many resources available to students to encourage them to reach their goals. Ana also advised new students, particularly female students, to get involved with events targeted towards women in engineering, as she wished that she would have been more involved with this group and its female membership.

While Ana's immediate goal was to graduate from her degree program, she planned in the long term to obtain a master's degree in engineering and pursue work within the industry. Ana did not have children and did not plan to be a stay-at-home mom, rather she said that she would prefer to dedicate her time to work and make her parents proud of her accomplishments. In terms of her science identity, achievement in

science is not only an achievement for her, and strengthens her identity; it is an achievement for her family.

Ashley

Ashley was a junior computer science major at UT-Austin from the Rio Grande Valley. Being a first-generation college student, Ashley had to navigate the college application process for herself with little guidance from family or school counselors. She ultimately chose UT-Austin because she visited the campus and appreciated the atmosphere, the top 10-ranked computer science program, and the fact that it was much different than her high school. Ashley's experience is particularly fascinating because she switched from a non-STEM path to a STEM path based on her desire to help people but through a more technical pathway. Upon enrolling at UT-Austin, she wanted to pursue a career in journalism, but a friend got her interested in computer science. She ultimately decided to pursue computer science because she could see the connection between computer science and the human touch of serving the people.

Her family was supportive of her choice to pursue computer science, as were her high school teachers, even though she didn't tell the latter group what she intended to major in. Ashley thought that her teachers might judge her for her major choice, so she didn't tell them. Her high school friends were initially surprised (as she wasn't on the STEM track) by her switch to a computer science major, but were ultimately supportive. At UT-Austin, her faculty members are supportive of her and she feels like there is a very close-knit community, especially since now they are all in the same building.

The opportunities that she has had, including the Freshman Research Initiative (FRI), have enabled her to be involved in field specific research experiences and connect with advisors and faculty members. She connected with an academic advisor in computer science, and was introduced to the computer science conference and women in computing conference. Ashley related that she sometimes had difficulty relating to non-computer science peers; she also stated that her computer science peers were a bit close-minded about the uses of computer science, but that they can relate more to her lifestyle in computer science (i.e. late night coding for class, continuously learning new, challenging computer science material). Her involvement with the Empowering Leadership Alliance provided her a role as a leader (vice-president) and enabled her to engage in mentoring and corporate relationship building events. Her biggest take-aways from this experience were seeing the opportunities that she gave to others and taking pride in the relationships that she has built and helped others build. Her interactions with her computer science peers were usually through ELA because it was harder to make friends in the classroom setting.

She maintained that computer science was different from any of the other majors in STEM. She believed that it was the most difficult and required a different mentality to understand the process of going from the smallest unit and to a much larger programming system. In terms of skills, Ashley believed that computer science majors must be competent and persistent in their endeavors; she did not have the competence when she came in, so she had to be persistent in learning the content and pursuing opportunities as a computer science major. A couple of years ago, she was not in computer science and

now it makes up a significant part of her life. She emphasized small victories in computer science, which made a larger impact, and reminisced about the events she has attended which have showed her the many ways in which she can utilize her degree.

When asked about her goals, Ashley has short term goals associated with learning new areas of computer science. She also had longer goals of graduation and becoming employed in the computer science field, especially in an area where there can be application for real world solutions. In the future, she hoped to engage in life-long learning within her field and pursue a masters in international affairs (integrating computer science) while gaining experience in the industry.

Carmen

Carmen, a junior in mathematics, was from the Rio Grande Valley. Early in her college applications experience, her mother "made it pretty straight forward that we weren't going to have enough money," so she only applied to colleges within the state, UT-Austin and one other mid-ranked, large university that she referred to as her "safety school." Initially, Carmen wanted to study business, but she was denied admittance to the business school.

Her second option when she applied was mathematics. She loved her introductory math courses and focused on studying mathematics. She was aware that she was analytical and wanted to understand the mechanics behind concepts while also being able to help society, rather than just figuring out equations. Her mother (a lab tech for a major oil company) and her grandparents are very supportive of her educational pursuits, even though they don't understand much about her major or intended career. Her high school

teachers did not have a great deal of influence over her pursuits. However, her female faculty advisor at the university was encouraging of her career goals, and her female professor role model is her "woman crush."

While at UT-Austin, Carmen participated in two organizations at the university: a mathematics organization for women and a computer science organization for women. Her participation in the math organization for women was primarily about outreach and connecting others to resources in order to make an impact (e.g. Women in Math Day). She said that seeing projects through and seizing opportunities to be involved with these groups, she did notice the lack of women and minorities, so she enjoyed seeing those opportunities open up. In terms of the mathematics community at UT-Austin, Carmen said that she was not active in community groups and was not branching out, with the exception of the women's organizations for mathematics and computer science that shared her view of advancing women.

In terms of advice, Carmen admonished new students in STEM to seek out help when needed from multiple resources (peers, friends, online) and to seek out that help early on in the process. She encouraged students to find their niche within the university and connect with peers. Carmen's advice to the university is to create 24-hour study lounges and more Hispanic alumni events (College of Natural Sciences, Texas Exes).

There are a number of fields that she believes she can choose from – she wants to explore her interests. She just does not want to be at a desk. She's even started thinking about faculty research topics. Her short-term goals included maintaining her academic success as well as finding an internship within her field. Long term, she would like to

utilize her degree and eventually earn a PhD and own a ranch in California which she admitted was a stark a contrast to her very "cerebral" environment right now. In the future, she believes that her science identity will empower her. Because there are a number of fields that she believes she can choose from, she would like to further explore her interests, particularly around academia.

Cindy

Cindy, originally from the Rio Grande Valley, is a senior majoring in computer science at UT-Austin. She is the daughter of very strict, conservative parents and is the sister for three brothers. Two of her brothers are interested in STEM fields (she's a mentor for them), and her boyfriend works in the technology field as well (he's a mentor for her). She became interested in computer science because she was interested in making things and because she thought that the boy toys were "cool," unlike those for girls. Her high school had a weak computer science program that she was a part of, so she took computer science courses at the local community college "for fun" to advance her knowledge.

She decided to attend the university based on the top 10 ranking of the strong computer science program. She also wanted to get away from her home, but coming to UT-Austin was quite a culture shock with the large number of students. Upon coming to UT-Austin, she considered many other majors and liked them, but she liked the tactile nature of computer science and did not feel comfortable in other majors. She found the computer science discipline allowed her to be creative and complete application based projects. She also liked her computer science peers. Even though her computer science

peers were difficult to connect with sometimes, they were "quirky" and "weird," much like she considered herself.

However, she was often the only woman in her classes, and, when paired with her shyness, she found it difficult to connect to peers. Cindy described her shyness as a salient part of her identity and indicated that it often played a role in how others perceive her. She does not have many friends, male or female in her program, and she often feels isolated from her academic peers. As a young girl she experienced sexual assault, and she suggested that she has used that shyness as a protective barrier or way to cope with the stress of past events. She indicated that sometimes she is just "numb" to feelings, especially in times of anxiety (like mid-terms). This numbness gave her an aura of calm despite the fact that she does not always feel calm within her computer science environment.

When discussing needed skills for STEM majors, Cindy identified perseverance and time management. She said that she just has to keep at it and do it while balancing a dense course load and scheduling time for other activities. The first semester for her was "trial and error" in learning to navigate the college pathway and classroom expectations. She asserted that STEM classes are harder and require critical thinking more than other courses.

She eventually joined an organization for women in computer science and an organization for women in engineering because she really enjoyed interacting with the other women who were involved with the group and she liked working with the children who were attending events. She enjoyed melding the field of computer science with

involvement with children. She found women with similar interests and she felt that it was an inclusive environment in both organizations.

In terms of advice for incoming STEM students, Cindy admonished them to not slack off, stay focused, and complete all the practice problems for assignments. She also encouraged students to make friends as stress relievers and create emotional support systems. She wanted students to be part of the UT-Austin student culture, but cautioned against joining lots of clubs that just target particular groups. She believed that students needed interactions with a variety of individuals, not just those who are most similar to them. In terms of the university's role, she wished that there were more one-on-one tutoring opportunities to prevent people from feeling shame when they don't understand something as well as more group tutoring.

When asked about her goals, Cindy stated that her short term goals were to graduate with a computer science degree and to eventually have a family. She did not want to pursue a PhD because she believed that it would cut into family time. Long term, she would like to find a technology start up and start making apps or working for a company like Google. In the future, she wants to have a direct effect on society using computer science – other majors or fields have an effect, but it is slow or indirect. She would like to make a direct effect by combining education and computer science. She ultimately would like to find a way to use her degree to give back to the community as well, especially the Rio Grande Valley where she feels that there are students failing to persist through to college and beyond.

Emily

Emily was a fourth year biology major at UT-Austin. Originally from the Rio Grande Valley, she attended a math and science academy and participated in an early college high school experience. As a first-generation college student she and her parents were unfamiliar with the college application process. She had never really been out of the Valley, but she applied widely to several schools across Texas. Originally, she was going to stay at a mid-sized university in the Valley, but she ultimately decided to come to UT-Austin. She did not know where she was headed, but said attending this university was the best decision that she ever made.

Ever since she was young, she wanted to be a doctor. She liked playing doctor to her dolls since she had seen the disparities in healthcare accessibility for family members in Mexico. Her principal and counselor at her high school gave her advice about medical pathways that brought her to UT-Austin. Once at the university, she had been most supported by one of her advisors who has helped with her medical school applications. She also felt validated in her aspirations by one of her female microbiology professors with whom she has had many conversations with about future plans.

She believed that dedication, will power, and a desire to make the world a better place are all part of being a science person. Even though she participated in an early college high school experience, she did not feel as though it properly prepared her for the rigor of this university. Emily struggled at times during the college experience and felt the least amount of validation when she got her first "C" in organic chemistry. She only

came to peace with it when she heard that this was normal to struggle and that she had tried her best.

Her advice to incoming STEM students was to be open-mined to possibilities and averse to settling on a course that you do not like. She also admonished students to plan ahead and become familiar with all of the great attributes of the institution, including the diversity of the student population. Her advice to the university was to try to build a sense of community within certain areas – almost like a family, creating bonds between students and a space to share challenges and understand journeys.

Finally, during the course of the data collection period, Emily graduated. She felt very proud of where she came from and what little resources they had to get her there. She felt as though after graduation that she is more competent and that she has a voice for the subject that she has studied. She has been hired through the Teach for America organization to start work in the fall as a teacher out-of-state. Her long-term goals are to attend medical school and settle with a family, being successful in both realms.

Esperanza

Esperanza, a Texas native, is a public health major at UT-Austin. Esperanza is also pursuing a minor in Spanish and is learning the Portuguese language, as well. Esperanza's parents, both from Argentina, divorced when she was 10 years old, leaving her father wealthy and her mother, with whom she lived with, in poverty. Esperanza grew up a voracious reader, always thumbing through the pages of the National Geographic, the New York Times, and the Economist that her father provided for her. From her

reading, she knew that she was draw to global health and development and medicine "sounded good," so she went towards that goal.

Prior to college, Esperanza mostly followed the footsteps of her older sister, pursuing language, history and the arts. However, moving towards college, Esperanza decided that she wanted to strike out in a different direction. She knew that she did not want to work for someone else and that she wanted to follow her passions while still being able to give back to her community. In addition, during her senior year of high school she was president of the Natural Science Club, reading articles and working on projects.

When applying to college, she applied to 12 institutions, both public and private as well as in- and out-of state, searching for a unique international approach to public health. UT-Austin offered a full ride scholarship, and she desperately wanted to be financially independent, so she attended college here. Upon coming to UT-Austin, Esperanza became involved with an integrated undergraduate honors program for students who are committed to studying the sciences but who also have interests beyond them.

During her time at the university, Esperanza has had several important global travel and academic experiences that have shaped her. First, she traveled to Bangladesh the summer after her freshman year at college to work on a global health project. She believed that this trip made her fearless since she went into an area with a language and a culture that she was unfamiliar with; she believed it made her more independent, more understanding. However, she began to feel as though she would make a more significant

impact long term should she build upon her Spanish language skills and knowledge of Latino cultures and focus on Latin American global health. Second, she described her Germany research in science and engineering in which she was selected from more than 300 students from the US, UK, and Canada to participate in research related to earth and agricultural science. This experience demonstrated to her that she was not deeply interested by earth and agricultural sciences, and she was determined to pursue global health even more seriously. Finally, the pre-med academy that she was currently working in focused on preparing her to take the MCAT. She felt very different than her peers, who were closed off from interests other than medicine. She often felt "diluted" because of her multiple interests and wondered if medical school is what she really wanted.

The advice that she would give incoming STEM students was to join organizations related to career interests and find a mentor to learn from their mistakes. The advice that she would give to the university was to engage more College of Natural Sciences majors in mentoring relationships and community programming (University Leadership Network, Polymatic Scholars, etc.).

Her short term goals were to elevate her grade point average, become fluent in Spanish and Portuguese, and maintain her long distance relationship with her Argentine boyfriend. Her long term goals were to continue improving her languages in order to do global health work in Latin America. She is particularly troubled by her language skills complicating her desire to work in Latin America; however, she is determined to integrate her interests into a career in global health in order to serve this region.

Isabel

Isabel, a third year human development major at UT-Austin, is a first-generation college student and first-generation English speaker. Isabel attended KIPP schools from fifth through twelfth grade. KIPP describes their schools as a "network of free, open-enrollment, college-preparatory public charter schools dedicated to preparing students in underserved communities for success in college and life" (KIPP, 2014). Isabel described that she had assigned college advisors for her relatively small graduating class (120 students), so it was a personalized approach to college applications. During her senior year, she had a block of time multiple times a week dedicated to applying to college and completing financial aid paperwork. Even though her brother, also in a STEM field, went to college before her, he provided little guidance to her because he wanted her to navigate the process on her own. Because she was a first-generation college student, and her brother provided little guidance, she was grateful for the guidance that her KIPP high school provided for the college application process.

Isabel's first choice for college was UT-Austin, but she was initially offered little financial aid, which would have made her enrollment impossible. Simultaneously, another of UT-Austin's rival colleges offered her a significant amount of financial aid. Unsure what to do, Isabel told her parents that she would pray about the situation. Isabel asked God to provide her with the money to attend UT-Austin; otherwise, she would take it as a sign that she should have indeed enrolled at the rival school offering the financial aid. At the last minute possible, UT-Austin offered a package that essentially would

create a “full-ride” scholarship for Isabel to attend the university, so she took it. Her prayers to attend UT-Austin had been answered.

In terms of her STEM interest, Isabel was never particularly good at English, so the science and math disciplines appealed and “made sense” to her. Language barriers caused her to connect to mathematics in school, as she was Spanish speaking. She felt as though she had an advantage knowing Spanish because she could distinguish language (Latin, particularly) roots. The logic and numbers were also easier with the language barrier, so it made math easier and reinforced her science identity. Throughout middle and high school, she participated in numerous science projects and competitions, even working with faculty members in a lab at a prestigious Texas private institution near her home. She was encouraged by the professors who she interacted with as well as the teachers at her high school – all how urged her to pursue a science field. She describes it as her world view and feels like a science person because she works in a lab and her peers recognize her work in research. She believes that he/she appreciates different things, has different goals based on her science identity, and is able to connect science to the bigger picture and use it for impact. She always liked science, but did not know all of the possibilities, now she is open to multiple opportunities. She believes that scientists are curious and dive into topics, like she likes to do. She also believes that scientists work in a lab, like she does. They are curious and seek different ways to solve a problem. Isabel considers herself a science person as she enjoys learning about science and couldn’t see it any other way.

Her parents were supportive of her choice in study, and, she notes, she feels "extra cool" when she talks to them. Her parents want her to succeed and often connect what they see on TV with her area of knowledge. They also are proud of her success and "show" her off to others when she is at home. Isabel related the level of influence that her parents have had over her experience. They are supportive of her in multiple ways; however, she does challenge UT to provide greater outreach to parents (especially on the importance of higher education). She believes that family, particularly taking care of family, is a huge part of who she is.

Before she arrived at UT, she contacted a professor about their research and got connected and volunteered in order to gain exposure to the research environment. Isabel described how she had always been fascinated learning about down syndrome, so she began to research possible UT-Austin faculty members who studied and conducted research in this area. She used the Internet to find these professors, and she emailed them about working in their labs. Because she had worked in a lab prior to college, she understood the importance of gaining this experience. She was interviewed at her first week of college, and she has worked unpaid in the lab ever since.

In her advice to incoming students, Isabel suggested that students should attend UT for their STEM degree because of the resources available. She admonished students to get connected if they loved STEM, especially Latina/os. In her comments to the university, Isabel believed that it is up to the students to use the resources given to them. She noted that she does not like the affirmative action politics at UT, but she believes that

Latina/os who are incoming students should be mentored in order to facilitate more positive peer interaction.

Her short term goal is to graduate in four years. She wants a science career otherwise her future would not be interesting. She knows she wants science, now it's all about narrowing. Isabel's long term goals include attending physician's assistant school and working in state hospitals. Eventually, she would like to open a public health clinic in Honduras.

Laris

Laris is a senior biochemistry major at UT-Austin. Originally from Mexico, she came to the US when she was twelve years old. Before college she did not feel as though she was a good writer, so she turned her interest to science. She considers herself to come from a family of "science people," as her parents and aunt are involved in science fields. Her aunt was involved in biochemistry, her father an engineer, and her mother a STEM teacher. Eventually her family encouraged her to pursue biochemistry based on the job opportunities and flexibility in careers available as well as an opportunity for preparation for medical school.

During her college applications process, Laris was the top 10% of her class, so she applied to three schools, two in-state and one out-of-state. The out-of-state institution was her top choice to attend college, but she did not get accepted. She did not believe UT-Austin to be a competitive school, and she believed that it was huge, but she liked the diversity that the institution offered.

She believes that resiliency and the determination to not give up on the first try has been a very important part of her experience. She learned resiliency from her parents, particularly her mom, as she was the first in her family to go to college. She also believes that a science person much be someone who can take the ideas that they are given and create their own ideas. In addition, a science person uses the knowledge that they have to find answers.

Laris' advice for incoming students is to research career opportunities for their majors and make contact early with those in their fields, but also keep an open mind if they must switch their majors. Also, she suggests that students should try to become involved with the areas of the college experience that they like while also working towards career goals. Finally, students should embrace the diversity around them. Laris' advice for the university is to create more opportunities for career exploration and improved company partnerships. She also suggested requiring externships as part of the curriculum in order to encourage students to learn about the career that they are pursuing.

Her long term goals involve earning a master's in public health and completing a medical doctor degree. At the time of writing, she has been accepted into medical school. She eventually wants to work in Latin American addressing the disparities in medical service and improving access to quality medical facilities. In looking forward, Laris knows that the goals she possesses are not easily had and cannot be accomplished alone and she will have to make the necessary collaborations. Her science identity, with its resiliency and goal-oriented nature, will push her to accomplish her goals. She acknowledges that her family shaped her experiences and instilled in her the confidence

to continue, and, even though she does not know the future, she has the qualities that she needs to succeed.

Lydia

Lydia is a fourth year engineering major at UT-Austin. She was raised in Mexico for eight years, then her family moved to Austin. In high school, Lydia was not particularly aligned with STEM disciplines, but her interests began to grow as she finished high school. Prior to college, Lydia participated in College Forward, a college prep program, and applied to other schools in Texas and out of state. She ultimately came to UT-Austin because she was denied or priced-out of other institutions. When she began her college experience, she was intimidated and was forced to change her study habits in order to keep up with the rigorous coursework. Because she was part of an engineering Freshman Interest Group, she was able to construct study groups of her peers. Now in engineering, she really enjoys the design and connects many of her experiences to memories of being with her architect father at work or being in drafting classes during high school. In engineering she really enjoys the design and connects many of her experiences to memories of being with her architect father at work or being in drafting classes during high school. She has also one brother who is also an engineering major at the university. Beyond the university, Lydia also mentioned that she has had some hardship because she has no extended family in the United States – they are all in Mexico. She finds support in her brother and engineering friends, but she still feels as if she has to prove herself. In terms of faculty interaction, Lydia admits that faculty do not pay much attention to the early years of undergraduate lives, however, she has much

stronger connections to faculty now than before. Many students drop out or switch majors over time, so they tend to focus on those who persisted. Because of this weeding out, there is often intense pressure from peers to succeed.

Lydia's experience in engineering has been greatly influenced by her presidency and involvement with the Society of Hispanic Professional Engineers (SHPE) and the Latina-focused subgroup of *Señoritas*. For her, SHPE has exposed her to a variety of professional engineers as well as allowed her to meet some of her "best friends." Lydia is also involved with SHPE's Latina-focused subgroup, *Señoritas*, which centers upon the development of Latinas in engineering. She has found a support system within these women where they talk about classes, commiserate about coursework and projects, and inspire each other. With the general involvement as president of SHPE, she has found that it is a community of Hispanic engineering majors that are like her "SHPE family."

When asked what skills are best for succeeding in engineering, Lydia believed that the ability to pick up on new concepts quickly is key. People who understand concepts very quickly are the most successful in engineering fields. Also, those individuals who were able to move out of their comfort zone and those individuals who have the ability to interact with professors and get questions answered were particularly successful. In terms of her own faculty interactions, she mentioned that it was very intimidating to approach non-Latina/o faculty members but that she still wanted to because she knew that other students were getting information via faculty members, so she had to interact with faculty members, even if they were not Latina/o.

In giving advice to incoming STEM students, Lydia tells students to pursue their interests because it is worth it, even if it is difficult. Do not be afraid of failure and take advantage of the support systems in place. To the university, Lydia would request better facilities and resources. She understands that they are working on it, but she still wishes that students had more areas because they are losing study space.

Lydia graduated and accepted a full-time engineering position. Long term, she hoped to earn her professional engineering stamp, move up in the company, or build her own company once she was more established.

Maite

Maite is a junior majoring in biology at UT-Austin. Maite's introduction of herself was unusual because she refers to herself as having two names for "two personas," one that is professional and one that is social. Therefore, in professional settings, she is referred to as one name whereas in social settings, she is referred to with a completely different, more ethnic sounded name than her professional name. For our interactions, she told me that I could refer to her as either, which I took as a good sign.

She was raised in Mexico until her mid-teens then her family moved to a Texas border town within the US. While in Mexico, she attended private school from kindergarten through high school, then as a result of the growing unrest in Mexico and a family home break-in, her parents were forced to relocate to the US side of the border. When she arrived in the US, she experienced "culture shock" as she referred to it. US classrooms were much more relaxed than she was accustomed to, and she had received a far more rigorous education in Mexico than she experienced in the US. Looking back at

her pre-college experiences, Maite described how she completed the International Baccalaureate (IB) Program. The IB Program, independent of governments and national systems, incorporates best practices from around the world that encourage students to think critically and consider their local and international environments (International Baccalaureate, 2015).

Maite became interested in science at a very early age, watching animal planet and collecting bugs to scare other girls. By middle school, she was really interested in biology, and her teachers were supportive of her interests. They were especially supportive given the lack of Latinas in STEM; she has also had support from university professors and graduate students who have taken extra steps to help her. Maite applied to several Ivy League colleges in hopes of gaining entry, but UT-Austin was her only acceptance to college. She felt lie a "reject" and like she was not good enough, but she did not understand at that time that UT-Austin was a respected research university. She thought that it was just another in-state mediocre institution. Even though she had never visited campus, she accepted UT-Austin's offer and enrolled. She was immediately taken aback by its sheer size and slowly came to understand the opportunities that the institution held for her.

However, she did not feel much of a connection with her STEM peer community and often her peers acted like they did not remember her. She described the environment as "hostile" and noted that while she does not feel out of place; she does feel as if she is different from her peers. Monica mentioned that she has no friends in her major, which she believed was weird, and she was baffled as to why she did not have any friends in her

major. In terms of faculty, she maintained that STEM was academically challenging and the faculty did not value her time enough to have meaningful meetings with her. She believed that there was very little faculty-student interaction and that the faculty members were often selfish. While she did note a couple of faculty who she felt were supportive, most of her statements regarding faculty were not positive. As a result, it did not come as a shock that she was still very connected with her Mexican family and Mexican elementary school peers, rather than her UT-Austin community.

Her advice to incoming STEM students was to have a clear goal of what you want, and to do science you must really want it. Maite admonished students that if they do not have a 3.0 grade point average in major, they might want to go to another field. STEM is frustrating and difficult. One must stay motivated, despite always being wrong. She also advised students to go to office hours, too. Her advice to the university is to provide more one-on-one time for students will faculty and staff. Also she believes that there should be more upperclassmen opportunities to engage in tutoring for upper division coursework.

Her short term goals are to maintain a 3.0 grade point average, maintain relationships with professors for recommendation letters, and continue to develop her non-STEM Latina/o organization. Her long term goals include obtaining a doctorate in a science field and moving towards industry, even though she is being pushed towards the academic pathway.

Maria

Maria, originally from a Texas border town, is a biology major at UT-Austin. Her interest in science began at a young age where she watched documentaries with her father, engaged in summer STEM projects, and managed her local STEM club, too. Throughout elementary and middle school, Maria was involved with gifted and talented programs focused on science research. In high school, she completed math and science projects and even participated in a major state college's research program for high school students. Maria attended an early college high school. She found the experience to be a benefit to understanding more about the university path and the diversity of college. She applied to several in- and out-of-state universities of varying prestige, but she was ultimately only admitted at in-state institutions. Initially, she was connected to a professor at another university, where she had been attending summer camp for years, who promised to find financial support for her and ease the college transition. However, her mother encouraged her to become more independent and go beyond her comfort zone, so she decided to attend UT-Austin, instead. She found UT to be friendly, but she felt really lost, confused, and an intense amount of competition from her peers.

Her family was supportive of her educational endeavors since childhood, especially her dad. She is very family oriented, so it has been difficult to be away and she is still learning to cope by putting time into other activities. When she arrived on campus, she did not know what she wanted to do, but has come to be interested in science subjects. Maria acknowledged that at the beginning she thought she could do anything, and then she became grounded and realistic about her abilities. She is still working to

accept the setbacks, but it is difficult. Maria related a difficult story about when she attempted to gain entrance to a program aimed at low-income college students interested in pursuing medical school. She was not accepted, and at first she was very discouraged, but the administrators urged her that she could still get into medical school without this experience. As a result, she has been looking for other opportunities, especially with targeted groups for Latina/o health professionals.

Her advice to incoming students centered upon urging them to get involved in study groups, stop procrastinating, and look for opportunities. Study groups allow students to bounce ideas off each other and become comfortable with questions and getting support. She says that procrastination is not a positive aspect and it can be difficult to stay on top of your work. Looking for opportunities, and taking them, even if they're not perfect, helps the community. She really appreciates the College of Natural Sciences' Townhouse series were there are more frank discussions about how they are doing things. She wishes that the university would promote finding a study buddy, rather than trying to tough it out alone.

Her short-term plans include finding a biology research group, but she found it difficult to get involved due to her status as an early college high school student (coming in as a junior). She planned to continue working and advance at her on-campus job with an environmental center until she can find a research group. Long-term, she plans to attend medical school. She maintains that she is on the fence about having a family, due to issues resulting from being in a science career and the focus on raising children.

Salma

Salma, originally from the Texas border region, is a junior majoring in nutrition at UT-Austin. During high school, she was involved with the National Honor Society, UIL, and participated in college dual enrollment. When applying to colleges, Salma looked at several in-state institutions, both public and private. Salma's parents believed that some of the institutions she applied to were too expensive while others were too far away. At the end of high school, she was accepted into the Gates Millennium Scholars Program (GMSP), a last-dollar scholarship award that ensured her ability to pay for college. The goal of GMSP is to, "promote academic excellence and to provide an opportunity for outstanding minority students with significant financial need to reach their highest potential" (Gates Millennium Scholars Program, 2015). She made a deal with her parents that if she received this scholarship, she could attend the college of her choice, and she did. When she came to the UT campus, she was very nervous because she had not visited before. Her parents did not allow her to go on college trips, so orientation was the first time that she had stepped foot on campus.

Initially, Salma did not like biology, physics, or chemistry. Her science interests began with a relationship with her doctor; she appreciated his approach to health which was more food based, rather that medicinal. She was also intrigued with how he talked about the body and medicine. Going back to her interactions with her doctor, she remembered that he talked about how many of the patients he sees have issues with their weight. Many of these issues are related to an unhealthy relationship with food and a basic misunderstanding of how food components influence the body. Rather than study

biology or medicine, which often perpetuate the use of pharmaceutical medicines, she wanted to study this issue in a more organic way. From these interactions, she wanted to study biology, but when she discovered more about the subject, she ruled it too "boring" for her to study, so she decided upon the more dynamic field of nutrition.

While at UT-Austin, she worked as a paid lab assistant for a faculty member. She and her faculty member agreed that she would not disclose to her peers that she was being paid for her time in the lab, but she found it difficult to remain silent when her lab peers would brag about themselves and take credit for the work without crediting her. For her, interactions with lab mates were frustrating, as she constantly found herself unable to demonstrate her worth to the lab, even though she was the only one actually being paid for her services.

Her advice to incoming students was to be aware of what you they were doing and "man up," meaning that people need to take advantage of the opportunities that exist and be aware of what is happening. Also she cautioned against becoming intimidated and mentioned that students should not stay tied to particular ethnic groups. To the university, she suggested that they find a way to do away with unproductive or unfriendly professors.

In the short term, Salma intended to graduate from her program and publish the research that she has been working on within the lab. After graduation, she intended to pursue graduate school and eventually work within nutrition research and policy. She believed that her strong identity as a science person will enhance her career aspirations,

increase her competitive edge with her peers, and allow her to continue relationship building in the field.

Samantha

Samantha was a second year human development and family sciences (pre-med) student at UT-Austin from the Texas border region. She completed kindergarten through fourth grade in Mexico, then she and her family moved to the United States. In high school, Samantha hated chemistry and biology, which made her pre-med track somewhat confusing. Her teachers in high school asked if she was science person because she was in math club and talented in several math and science areas, but she did not recognize herself as such. She came from a low income high school, but took the initiative to apply to UT-Austin through their outreach center near to her home. She applied to several other in-state institutions, both public and private, as well as one out-of-state institution. Her high school was large, but still small compared to UT-Austin and she described transitioning to campus as a "big shock."

When she came to UT-Austin, she changed her focus of study several times before finally settling within a STEM area. Finally, she was became involved with a STEM area through an initiative focused on pushing students to think independently, articulate their reasoning, and improve their focus. Project SEED, "fosters lifelong learning skills. Students are pushed to think for themselves, articulate their reasoning, improve their focus, and contribute to the group discussion" according to their website (Project SEED, 2015). The faculty members at the university were very helpful and even

though her advisor was hesitant to allow her to switch into her major after so many major changes, they worked it out to where she could join her peers in the major.

In terms of family, she most inspired by her oldest sister who went to college and became a social worker. She was also influenced by her mother, whom she seeks to make proud. Her family was really excited about her STEM choice, but they are not necessarily happy about her not coming home frequently. When asked about her mother, Michelle recounted that her mother was very supportive of her taking research opportunities, but her mother is still afraid of her being away so much and losing time with her. Michelle is inspired by her mother, for her mother has been forced to overcome many obstacles and has an "I have to do it" attitude. She believed that if her mom could overcome so many obstacles, then she can, too.

When asked to give advice to STEM incoming students, Michelle admonished students to consider what they are doing and, if they are really interested in it, do it. When asked to give advice to the university, she wanted the university to have more interactive professors for the STEM classes.

Samantha's short term goals were to finish with a strong grade point average while her long term goals aligned with her interests in graduating from college and attending medical school. In the future, Samantha desperately wants to be a doctor. She remarked that she has no idea what she would do if she were not a doctor. She believed that her STEM major would take her where she wanted to go, even though it may be the harder route.

Sofia

Sofia, a Houston area native, is a senior engineering major at UT-Austin. When applying to college, Sofia only applied to UT-Austin, and only to engineering. For many students, this would be unthinkable due to the competitive nature of the admissions process for the School of Engineering. She asserted that she wanted to stay close to home and that she believed the university to have the best engineering programs in Texas. She also did not want to leave Texas because she did not want to pay out-of-state tuition. She knew that she always did well in math and sciences in high school, so she decided that she would continue on that route.

She also chose engineering as a field because she has many family members (father, brothers, and sisters-in-law) who work in this area and because of the broad application of engineering. She even admitted that, "I was kind of born into it." She grew up working with her dad at his engineering job, and it was not a question of whether she would be involved in engineering, but rather a question of what type of engineering. Sofia felt torn between the different areas, all represented through the position of her family members.

She came from a large, under-resourced high school and felt academically unprepared for college when she arrived at UT-Austin. When pressed as to why she felt unprepared, she admitted that everyone at the institution is extremely intelligent. It can be overwhelming to be forced in to such a competitive environment with peers who are much more prepared that she was. She related how she felt that many of her peers had a better understanding of the college process as a result of their STEM or professor parents.

She also related that her high school was not competitive and she was unprepared for the sheer amount of homework and assignments that would be expected of her when she entered the program.

Upon coming to college, she received a scholarship from the Women in Engineering program and was immediately involved in their organizational events, including meeting the director and other students. However, she was the only one from her high school that entered as an engineering major. All of her friends attended all of the orientation sessions together, but she had to complete everything on her own. She was lost much of the time in the beginning and is not sure what she would have done without the WIE support system. Paradoxically, though, she mentions that women did not reach out to her for friendship and support until her junior year, even though she wishes that they would have reached out. She maintains that for studying, she has always sided with men, and for fun she has sided with women.

During the course of the study, Sofia graduated and assumed the full-time engineering position that she had landed before graduation. She felt lucky and extremely fortunate to have landed this position, especially when she believed her grades to be lackluster. Long term, she was interested in becoming a team lead and possibly getting her master's in business administration. However, she was also adamant about wanting to leave time for raising a family and traveling.

Tatiana

Tatiana, a Texas native, is a fourth year public health major at UT-Austin. Her background is particularly interesting, for she has a Peruvian mother, an American White

father, yet she considers herself Ecuadorian because she spent her childhood in Ecuador. When asked about other identities, Natasha brought up the fact that she often feels like a foreign study student because of her background. She was born in Ecuador, then moved to New Jersey at age one, then moved back to Ecuador for seven years before returning back the United States so that she could gain residency within the country before high school and college. She spent her formative years in Ecuador, her customs and beliefs were shaped in Ecuador, and she often feels out of place within the American work lifestyle and focus on material goods. She often travels to South America and feels as though it has expanded her worldview and provides her the ability to understand people and judge less.

She applied to several other schools, including in-state public and private institutions, but she wanted to move, so she chose to come to UT-Austin. She enrolled under the automatic enrollment policy and immediately found the institution to be a very beautiful, liberal as well as large, intimidating space. At first, she was unaware of the public health major at UT-Austin and thought that she would graduate as a biology major with a pre-med track. Tatiana was inspired to pursue public health by the movie *Beyond Borders* with Angelina Jolie in which she realized the importance of public health. She was also inspired by the work that former president Jimmy Carter has done to expand the support for public health around the world. At the university, Tatiana has been supported by her faculty mentor, a woman who has guided her through the research process. She also mentioned that her Dad was very into science and would send her emails about

scientific news or other things he would read about. She felt that this was a source of motivation.

The public health major has allowed her to pursue her interest in community level healthcare while combining her interest in healthcare policy. She pursued this field because it is, "science for social change." She maintained that the public health major at the university is rooted in scientific concepts and is housed within the College of Natural Sciences, so it is rigorous. She takes all of the same coursework as other students within the college, but she believes that there is a lack of understanding regarding the public health major. Tatiana feels that during her time as a public health major, she has developed skills of dedication and perseverance. STEM majors are difficult, and she maintains that one cannot allow one challenge to impede progress. At first, her family was concerned when she switched from a pre-med track to public health, especially about her ability to be gainfully employed and repay loans when she graduated. However, she articulated her interest in public health and tied her interest back to the same interest that her parents held when they were involved with non-profit ventures.

Her advice for incoming students is to be sure that this public health pathway is really what they want because it is not financially lucrative. Also, she cautions against students who might think of using the public health track as a way to "pad" their medical school application. She also admonishes students against procrastination and better study habits as well as encourages students to be open and willing to ask for opportunities to improve their college experiences (i.e. tutoring, research). Her advice to the university is to continue to work on the class sequencing for the public health major given the

program's newness. She also wishes that the university would connect public health majors to more internship opportunities to gain experience and more mentorship by faculty of color as a way to see examples of successful people of color within the public health area.

In the short term, Tatiana will continue to work for a community health clinic, improving community access to healthcare while she finished her degree. She loves to work in this capacity and realized the importance of working in this capacity, especially in her work with the Hispanic community. Tatiana also worked part-time with the Women in Natural Sciences organization, assisting the administrator with events and planning. In the future, she will apply to English teaching abroad while she is working in these areas and deciding what she will do next. Tatiana has decided to attend graduate school, rather than go to medical school, as this choice seems more fitting for her long term goals. She has also considered the Peace Corps as a possibility, too. Long term, she would like to work for the Carter Foundation or possibility the Center for Disease Control.

Victoria

Victoria, originally from the Texas border region, is a senior engineering major at UT-Austin. A first-generation US citizen, Victoria became interested in her pre-college anatomy and physiology classes because a Latina teacher challenged her in her work and encouraged her to pursue STEM as a serious career path. She began asking questions related to an interest in the field, and even participated in the High School Aerospace Scholars Program through NASA.

While in high school, Victoria applied to three colleges UT-Austin and two out-of-state private universities with extremely competitive admissions processes. Before coming to UT, Victoria visited UT-Austin during UT explore and greatly enjoyed the Austin culture and the laid back nature of the people who live here. By coming to campus, Victoria sought to "get out" of her border town and start the next phase of her life. Her mom wanted her to be in engineering, but also does not want her to be stressed, so she is torn in terms of her support. Her father was STEM focused, but he did not complete a degree. She maintains that they are proud but have no idea what she is actually doing.

Victoria surprised me mid-way through the interview by disclosing that she had a daughter who was born while she was in high school. I was shocked, but not surprised, to see that she was reluctant to tell me. She did not generally disclose to her STEM peers and faculty that she had a child and had only recently told her faculty research mentor. She was fearful that faculty will believe that she cannot produce at a reasonable level because of her family and that she is a "gamble" and could be an issue at a later time. She felt as though she may be overlooked for opportunities because others regard her as "busy" with her family or that she will not be given the same opportunities as others. She became a teenage mother during her junior year of high school and people began to dissociate themselves from her and question whether she would continue on her intended college STEM path. She harbors a certain amount of fear, it seems, related to disclosure of this information and ensuring that she is not judged by her child rather than her scholarship. Many thought that she had made a poor life decision, however, her parents

helped her out and she was able to come to UT while they took the primary responsibility of raising her daughter while she was in college. She returns how periodically to see her daughter.

Her faculty mentor is female and has been a role model for Victoria – "I want to be her when I grow up." She recognizes a good work and life balance in her faculty mentor and often talks to her about her experience. She related that she does not have a lot of contact with other faculty members, but she finds most of her faculty to be challenging yet approachable. She found a peer support group at UT through her engineering peers. They study together, go out with each other, and act as a support system for each other. She believed that each of the young women she connected with had a forte area and they balanced each other and were able to provide help to each other, when needed. They were committed to "making it out" together. There were all difference races and ethnicities and had diverse backgrounds, but these women respected and were supportive to each other.

Her advice to Latinas coming to the university's STEM programs was to pursue one's passions and not be pressured about one's choices. She urged students never apologize for who they were or their beliefs. She also suggested that they find a good supportive network during their time here.

During the course of this study, Victoria graduated and was accepted to her first choice engineering graduate school program. Her long-term goals include the desire to complete a post-doctoral position abroad prior to earning a tenure track position in academia.

Student Profile

The student profile was compiled from information received primarily through the participant questionnaire while the thematic results represent information received primarily through the interviews and focus groups. The student profile was created in order to more fully understand the demographics and experiences of the study's participants (see Figure 7).

Variable	Response
Age Range	19-23
Majors	4 engineering, 3 biology, 2 computer science, 2 human development and family sciences, 2 public health, 1 biochemistry, 1 mathematics
Minors	pre-med, architecture, disease and development in Latin America, English literature, health policy and management, teaching
High School Top 10%	93%
First-generation College Student	68.8%
Mother's Origins	Mexico, US, Argentina, Honduras, Peru
Father's Origins	Mexico, US, Argentina
Mother's Education Level	Approximately 50% held high school diploma/GED or less
Father's Education Level	Approximately 43% held high school diploma/GED or less
Income Level	Approximately 18.8% of participants indicated family yearly incomes below $30,000
Languages Spoken	English, Spanish, French, German, Portuguese, Italian
Language – School	Predominantly English (62.5%)
Language – Home	Predominantly Spanish (68.8%)

Figure 7. Student Demographic Profile

All of the participants within this study were traditionally-aged undergraduate college students. Their ages ranged from 19-23, with the greatest number of students concentrated in the 20-21 range. There were 16 undergraduate Latina participants in the research study. Four of the participants (25.2%) were engineering majors. Three of the participants (18.8%) were biology majors. Two were computer science majors (12.5%). Two were human development and family sciences majors (12.5%). Two were public health majors (12.5%). There was one participant each for the biochemistry (6.3%), mathematics (6.3%), and nutrition areas (6.3%). Nine of the sixteen participants in this

study held concentrations in various areas. These minors included STEM concentrations as well as non-STEM concentrations. Within this study, 15 of the 16 (93.8%) undergraduate Latinas in this study were in the top 10% of their graduating high school class. Eleven of the students within this study identified themselves as first in their family to go to college (68.8%).

Nine of the sixteen participants' mothers had Mexican origins (56.3%). Four of the participants' mothers had origins in the US (25%). One student's mother had origins in Argentina (6.3%), one had origins in Honduras (6.3%), and one had origins in Peru (6.3%). When asked about their father's origins, twelve of the sixteen participants indicated that their fathers held Mexican origins (75%). Three indicated that their father's origins were from the US (18.8%), and one indicated that her father had origins in Argentina (6.3%).

When asked about their mother's educational attainment level, students indicated a variety of completion levels. Three of the participants indicated that their mothers had completed a master's degree (18.8%), one participant indicated a bachelor's completion (6.3%), one participant indicated associates completion (6.3%). Three participants indicated some college completion (18.8%). Four of the participants indicated that their mother had completed a high school diploma or a GED (25.1%). Four participants indicated that their mothers held a middle school education level (25%). When asked about their father's educational completion level, three participants indicated that their fathers had completed a master's degree (18.8%), three had completed a bachelor's degree (18.8%), and two had completed an associate's degree (6.3%). Two students

indicated that their fathers had completed some college (12.5%). Three students indicated that their fathers had completed a high school diploma or a GED (18.8%) while one participant indicated that their father had completed a middle school education (6.3%) and two participants indicated that their fathers had completed elementary school education (12.5%). One student indicated that her father had never attended school at all (6.3%). When asked about their family's yearly income, three participants indicated that their families had yearly incomes below $30,000 (18.8%). Five participants indicated that they had yearly family incomes between $30,000-$59,000 (31.3%). Five participants indicated that they had yearly family incomes between $60,000-$89,000 (31.3%). Two participants indicated that their yearly family income was $100,000+ (12.5%).

Within this study, eleven of the sixteen participants indicated that they spoke both English and Spanish (68.8%). One participant spoke only English (6.3%), one participant spoke a combination of English/Spanish/French (6.3%), one participant spoke a combination of English/Spanish/German (6.3%), one participant spoke a combination of English/Spanish/Portuguese (6.3%), and one participant spoke English/Spanish/Italian (6.3%). Ten of the sixteen participants indicated that they used the English language in school settings (62.5%), five participants indicated that they used a combination of English and Spanish, and one student indicated that she used the Spanish language within school settings. When asked about the language spoken at home, eleven of the sixteen participants indicated that they spoke Spanish at home (68.8%), three indicated that they spoke English at home (18.8%), and two indicated that they spoke a combination of English and Spanish at home (12.5%).

Summary

The purpose of Chapter four was to provide vignettes of each of the study's participants, including key information related to pre-college and college STEM experiences in order to set the context for the study's findings and provide relevant background information about each of the participants. From these vignettes, one can see that these Latinas became interested in the STEM fields primarily at a young age, but there were also some Latinas who became interested at much later points in their development. The Latinas in this study experienced influences on their STEM interests from a variety of sources, including from peers, faculty, and family. Participants had a wide range of pre-college and within college experiences and activities ranging from faculty research and STEM-targeted events to involvement with organizations and serving as a tutor and role model. There were a variety of short- and long-term goals associated with these students, several of which included the desire to give back to their communities and balance the rigor of a STEM career with the enjoyment of outside life. During the study, several students graduated and moved on to STEM careers and graduate school while others remain in process to complete their degrees.

Chapter 5: Competence, Recognition, and Performance: Latinas Making Meaning of STEM experiences and Developing Science Identities

Chapter five, aimed at answering the first and second research questions, utilizes the study's primary theoretical framework to explore science identity development for Latinas in STEM (Carlone & Johnson, 2007). Utilizing this framework for analysis allowed me to understand to how the Latinas in STEM within this study made meaning of their STEM experiences and developed their STEM identities. The first and second research questions are: 1) How do Latinas develop and sustain their science identities during their college experience? 2) How do they make meaning of their formal and informal STEM experiences? Utilizing Carlone and Johnson's (2007) science identity framework, the findings suggest Latinas in STEM negotiate their science identities through their experiences with building competence, becoming recognized as a STEM "person," and performing in STEM contexts. To explore the data, three over-arching constructs from Carlone and Johnson's (2007) science identity framework were used: competence, identity recognition, and performance.

This chapter explores the presence of these constructs within the data and is structured around three sections to describe how Latinas make meaning of their STEM experiences and develop their science identities. The first section explores how Latinas utilize competence to develop their science identities while also examining the limitations of using competence as a positive aspect of science identity development. Students believed that their understanding of the world from a STEM perspective meant that they were developing a science identity. Other students recognized that there were limiting

factors regarding the use of competence in identity development, including the need for advanced knowledge and training in one's field and the fleeting nature of STEM competence within an academically rigorous environment.

The second section examines how Latinas used self-recognition and outside recognition to construct their science identities. For the participants of this study, self-recognition as a "STEM person" emerges from one's acknowledgement of personal enthusiasm for learning STEM concepts, one's ability to persist despite academic struggles, and innovate and think critically within the field. Students also acknowledged that outside recognition, particularly from STEM peers and faculty influenced their science identity development; to a lesser degree outside recognition from family also influenced that development as well.

The third section explores how Latinas develop science identities through constructing an understanding of their performances in STEM environments. Students felt as though they performed their science identities in front of others by utilizing STEM humor and allusions, modifying their tone and content of their speech to reflect STEM authority, and engaging in STEM research activities. The chapter concludes with a synthesis of the findings related to research questions one and two that sought to describe how Latinas within this study made meaning of their STEM experiences and developed their science identities.

Competence: Developing an Understanding and Scientific Identity

Knowledge and understanding of content within a STEM discipline played an important role in the science identity development of the participants. Carlone and

Johnson's (2007) science identity framework established competence as an element of the science identity development process. Within this framework, evidence of competence emerges when a student demonstrates the presence of "meaningful knowledge" and a desire to "understand the world scientifically" (p. 1190). All of the students within the study agreed that possessing a high level of competence within their subject area was connected to experiencing the world around them in a different way than their peers and allowed them to feel more confident in asserting their knowledge when interacting with others. However, they also identified several limitations to using competence as a means to develop their science identities.

Understanding one's environment from a STEM worldview. Several students discussed the connection that increased competence had in relationship to their academic self-concept and experience within the STEM context. By increasing their competence, students felt more positively about their academic self-concepts and were more comfortable interacting with STEM peers and faculty members, knowing that they possessed the knowledge and skills needed to be successful in their major. Maite, biology major (pre-med), enjoyed the ability to, "know *why* things happen, sometimes even *how* things happen" based upon her understanding of biological concepts. Her understanding of the *why's* and the *how*'s of biological concepts was built from a solid foundation of STEM education and increased with years of voracious reading of scientific journals and multiple experiences of hands-on research while in college. Not only does Maite possess competence around *why* biological phenomena happen, she understands *how* those processes take place because she dedicated her college experience to internalizing those

concepts and making them a part of the way that she understands the world. Because she thoroughly understood her material, Maite felt empowered both inside of the classroom and her research lab as well as outside in her interactions with peers and faculty members.

For Ashley, a computer science major, a deepening sense of technological competence has encouraged her to feel more confident about her abilities and development of an identity around computer science:

Illustration 1: Computer.

> A couple of years ago I wasn't even into technology and now I can't live without technology around me. My laptop represents the fact that I can do my homework, or work in a project or even last summer that I was working on personal projects I had my laptop. For me it kind of represents the stuff I was able to do in the summer and what I learned…I mean we are all characterized by our laptops like if we go to a hackathon.

She described the picture above, an artifact from interview two representing her competence with technology and computer science, as a major part of her characterized identity. Initially, Ashley was unsure of her desire to major in computer science, but after increasing her knowledge and skills over the summer, she felt more competent and ready

to continue as a computer science major. Because she gained a deeper understanding of the subject, she felt a greater sense of competence and identity.

Other students described how their contextual understanding of STEM made them feel more competent and able to understand their worlds in new ways. Students often took the initiative to gain additional knowledge or think critically about their environments. As a result, students felt a sense of understanding about the world around them and were able to make meaningful contributions to their class discussions. Lydia, an engineering major, created connections between the knowledge that she has acquired within her engineering classes and the structures around her. Lydia stated that:

> …now that you walk into a building and for example I'm looking at the structure and at the beams and at the pillars and, "Oh I understand what's going on" and that type of thing. It's very nerdy but I like it.

Because Lydia has gained the knowledge needed within the engineering field, she now understands the world around her as an engineer would. She has built a level of competence where she feels as if she has an engineering perspective of the world, understands "what's going on," and is comfortable with the spaces that she occupies. Rather than seeing only a building, Lydia understood the elements working together to maintain the structure and integrity of the building. Although she admitted that this way of thinking may be "nerdy," she enjoyed her perspective and the feeling of competence that it gave her.

Esperanza, a public health major, developed her science identity by enhancing her competence level with outside reading and further critical thinking:

> Realizing that I was contributing something significant to class discussions about science. That I was doing things that I guess other science students weren't, like

> doing a lot of research on my own about what's going on. Taking initiative to understand how the—how what I was studying in science meant in the context of the world.

Within this quote, Esperanza, a public health major, noted her science identity development was partially defined by her realization that she was "contributing something significant" to the conversation in classes and doing what "other science students weren't." Rather than passively attending class or merely completing the required reading, Esperanza surpassed the basic requirements and took the initiative to complete additional readings and integrate that knowledge in a meaningful way into her class discussions. Her competence within the field grew and she was able to make a significant contribution to the discussion, thus enhancing the way that she felt about her STEM competence and ability to succeed within the STEM context. Esperanza stated that the science identity she has developed during college would help her in the future, for she would have a greater scientific knowledge base and more technical skills than her peers as a result of her taking the initiative to explore subjects on her own.

Finally, students discussed their feeling of competence in relationship to their ability to speak knowledgeably on STEM subjects. Increased understanding of STEM concepts enabled students to speak to others with a sense of authority regarding their area of expertise. Emily, a biology (pre-med) major, connected a sense of heightened competence with her college STEM journey and subsequent graduation. Within interview two, Emily produced the artifact below, a Texas Exes cup, as a representation of her science identity and the competence that she feels in speaking with others as a STEM graduate:

Illustration 2: Drink.

> It just transformed me; it just made me a different person, more responsible, more independent. It opened my mind to new opportunities and new views that I didn't know before. It just blew my mind. And now that I look back whenever I was a freshman, it just blows my mind how much I've learned here by myself. And the stuff I've been through here. It's been a struggle and it's been different than I thought. It's been hard, obviously. But if I were to be accepted, or that sixteen year old applying for college and being accepted to UT, I would do it again…it kind of gives me that strength and secureness to speak to someone who I thought was different than me, in my own little mind. I feel now that I am competent enough to speak to other people …

Emily recounted in her interview how the rigor of the biology department not only transformed her academic thinking but also elevated her level of competence and provided a sense of accomplishment regarding all of the academic hurdles that she had to overcome. As a graduate of UT-Austin's biology department, Emily now feels empowered by her level of competence to speak to others regarding her knowledge of scientific concepts.

The limitations of competence. Although all of the study's participants cited a certain degree of competence as important to their identity development, several participants noted the limitations of utilizing competence to develop one's identity. Students noted the complicated relationship between academic grading and the

perception of competence within the STEM fields. In addition, several students pointed out the shortcomings of utilizing undergraduate competence alone, citing the need for additional advanced knowledge of their fields or further experience needed to make an innovative contribution to their fields.

In terms of academic grading, the participants of this study struggled with whether formal assessment of their skills reflects their true level of competence. For some students, grades were discouraging to their feeling of competence in a STEM area, but for others they were encouraging only if they felt that they have been hard-earned. If the student felt as though her grade has been inflated in any way, though, she felt as if she did not deserve that grade and did meet field expectations for competence.

Even though, as discussed above, Maite, a biology major (pre-med), felt competent in her STEM knowledge and skills, she sometimes felt discouraged by the grades that she received in her major classes. Although she remained committed to her field, she often doubted if all of her hard work and sacrifice were worth the trouble of struggling through coursework and lab work in order to receive less than stellar grades. She related the following story:

> When I was a sophomore, I was like, "Should I change my major now that I can or not?" Because I enjoy my classes, I enjoy the stuff that I'm learning a lot, but I get discouraged by my test scores because honestly I have really bad test scores. And I'm like, "Am I really good enough? Do my test scores really reflect what I know? Are they worth it? Am I dumb? What's going on?"

In Maite's case, academic grading was a major threat to her perceived level of competence and made her doubt whether she should remain in the major. Although she truly enjoyed the content of her courses and felt as though she was learning a great deal,

she was discouraged by the assessment of her competence. Often she did not receive the academic grades that she felt reflected her high level of competence. She related that she considered switching majors to one in which she received better grades but ultimately decided to stay with her major.

Maite went on to relate how her feelings of competence were diminished through the grading process:

> It's just that kind of stuff where you feel confident and that you think that you know what you're doing, and then out of nowhere it's like bam! It hits you on the back of the head and says, "No, you're dumb. Don't feel good about yourself, it's wrong. You need to work harder." But that gratification is very feeble. Like it's there for 5 minutes and then it goes away for the next 48 hours.

Even though she felt competent in many ways, formalized academic grading would remind her of how "dumb" she was and how she needed to perpetually "work harder." In Maite's experience, gratification was fleeting and building a feeling of competence about one's understanding was difficult when academic grading continued to demonstrate one's lack of subject knowledge. She feels less discouraged when grades are lower than desired, but she mentions that "gratification is feeble" and that you need that constant performance of knowledge. The relationship between grading and competence levels is further complicated by how much the student trusted that they earned the grade that they received. Students who received higher grades did not always feel more competent. Some students, such as Esperanza, felt as though they received grades that did not accurately reflect their lower level of competence:

> I do not feel I deserved that A. There was like a heavy curve in that class. In that example, no. I feel like the actual grade I deserved in that class was a C for how much I understood the material. It's kind of embarrassing.

Esperanza, a public health major, related how sometimes she felt as though her grades, even though they were high, did not reflect her competence. As described above, Esperanza took the initiative to complete additional readings for her classes and connect her understanding of the content to the STEM context around her. However, it is not in every case that Esperanza felt as though her grades represented an increased sense of competence. Rather than feeling an increased level of understanding based on her grades, Esperanza felt embarrassed by her grades and undeserving of the outside perception of her understanding. At this point, she felt as though she still had much to learn and often wavered between feeling prepared and competent and judging herself very harshly.

Another limitation of competence within the study regarded the need to gain additional advanced competence in order to develop their STEM identities. While undergraduate competence was important to these majors, the concept of competence was complicated by the need of these students to continue on with their studies or seek additional training in order to feel as though they could make a contribution to their fields. This seemed particularly true for those participants who were more closely aligned to goals associated with medical or graduate school and engineering majors who sought the need for experience in the field. Samantha, a biology (pre-med) major, felt unsure about her science identity development because she was not yet fully trained in her subject area:

> Well, I cannot cure a person; I cannot tell you what is wrong with your kid. But I can teach the basics of it. What I've learned, I can teach it to someone; I can help you if you need any help. I'm not going to tell you something that I don't know, but from what I've learned I can contribute that.

Samantha believed herself to be a science person because she finds the study of human development fascinating. She believed that a science person looks at the details and understands the concepts thoroughly. She appreciated a life viewed through a more technical, scientific lens.

She believed that unlike most people, she did not take science for granted but instead saw it within its larger context. As a freshman, she felt directionless. Now, she is passionate about what she studies and is truly interested in it. However, because Samantha's goal is to become a doctor, she felt as though she was not fully competent in her subject matter yet, even though she was nearing undergraduate graduation. She saw her journey towards competence as one that has just started since she must finish many more years of coursework, residency, and certification until she is ready to become a doctor.

Similar to Samantha, Tatiana, a public health major, agreed that she also needed additional education in order to feel competent:

> I think I still have a ways to go before I can officially call myself a scientist. I don't know, in my mind that means you have more education than a bachelor's but I feel like I'm on the right track now. But I feel like there's so much more knowledge to be had.

Tatiana believed that she was a science person because she was interested in the scientific view of what was going on around her – to her everything related to science. And yet, she believed that the competence acquired during her bachelor's degree was not enough to call herself a scientist. Although she felt as though she was "on the right track," the need for additional coursework within graduate school limited the level of competence that she felt as though she could attain within her undergraduate years. According to Tatiana's

perspective, feeling competent enough to call oneself a scientist correlated closely to the level of formalized education one possessed.

Beyond the need to complete additional years of formal education in order to feel competent, other students described the need to gain field experience before they were able to make a contribution to the field. Lydia, an engineering major, acknowledged the competence that she had built during her undergraduate work, but she related a desire to learn more in her first full-time career position in order to feel more competent within her field:

> I think so, but I also know that I have a lot more to learn. Right now it's like I feel competence because I'm graduating and I know the basics of what I'm going into but I don't feel like I'll be able to actually contribute like new knowledge or new ideas for maybe a year or two when I feel more comfortable knowing what I'm doing.

Lydia described the need to gain further knowledge in order to move her understanding from the basic level at the undergraduate level to a more advanced level of knowledge gained by applying that knowledge to experiences in the engineering field. Although she acknowledged her competence at the undergraduate level, she maintained that in order to make a contribution to the field in terms of new ideas, she will have to have one or more years of understanding engineering as an applied field.

Summary. The Latinas in this study developed their science identities by gaining an increased feeling of competence within their STEM discipline. Their understanding of STEM concepts and emersion in their learning experiences allowed them to gain a more positive academic self-concept and connect their understanding with their everyday lives. In contrast, for some students an understanding of their level of competence was

complicated by issues of the academic grading system as well as a need to acquire more formal education and practical experiences.

Science Identity Recognition: Self-recognition and Beyond

Carlone and Johnson's (2007) science identity framework explored science identity recognition as an essential element of the science identity development process for women of color. Within this framework, evidence of science identity recognition takes two forms: a woman of color must first recognize herself as a "science person" and then be recognized by others as someone contributing to the scientific community. When these constructs were applied to this study, all of the students expressed self-recognition as a STEM individual. Students self-identified first through their agreement to participate in a study focused solely on exploring the experiences of Latinas in STEM disciplines. Within the study, students described their self-recognition in many forms related to their learning patterns and STEM perspective as well as their dedication to persist within a rigorous STEM degree. Students also illuminated difficulties that they had related to self-recognition, including the desire to further define their science identity.

Students discussed outside recognition of their science identity most often by citing their STEM peers and faculty as the primary individuals from whom they would like recognition. From peers, students sought recognition of their ideas and an opportunity to fully participate in the idea exchange within the STEM classroom and on projects. From faculty, students sought recognition of their abilities and skills and a desire to know that their faculty members were interested and invested in their role as a growing member of the STEM community. To a much lesser degree, students also

described the importance of familial recognition of their Science identity as essential to the identity development process. Family recognition was important to the students of this study, for it reinforced that their families understood the deep connection that they had to the STEM disciplines as well as at times served as a proxy for the lack of peer or faculty recognition present within the university STEM setting.

Self-recognition. All of the participants within this study at least partially self-identified as a STEM person based on their STEM interests and experiences. Most students cited their enthusiasm for learning STEM concepts and ability to innovate and think critically as well as their academic persistence despite struggle as reasons why they identified as a STEM person. However, several students discussed the limitations of their ability for self-recognition and the complications related to science identity loss. Students often believed that they were only in the early stages of their Science identity development or that they needed additional specialized interests. Science identity loss was a major concern for several students who described how lost they might be should they not be involved with a STEM discipline.

Enthusiasm for learning, innovation, and critical thinking. Almost all of the participants within the study cited their enthusiasm for learning STEM concepts and their ability to innovate and think critically as major indicators of why they self-identified as a STEM person. Beyond feeling competent in their STEM disciplines, students identified a strong desire to engage with STEM materials and participate in the process of discovery in multiple ways. This enthusiasm was often described in contrast to their STEM peers and seemed to be a more prevalent occurrence for engineering majors. During her artifact

discussion in interview two, Victoria, and engineering major, described one of the objects that she brought, an atomium replica, as an integral part of her identity. She related that:

Illustration 3: Model.

> It kind of symbolizes that I am a scientist wherever I go…I feel like a genuine intrigue like I want to learn I mean cause I have a lot of facts and history inside I have a genuine curiosity and I feel like you don't than what are you really doing.

Victoria believed that a science person thinks critically and has confidence in their intellect. She stated that she viewed herself as a science person because she held a genuine interest in the area and loved reading research articles, even outside of classroom assignments, and thinking about science in context. The artifact that she brought is a replica of the life-size version of the atomium in Brussels, Belgium. Victoria not only identified herself as a "science person," but she went one step further to identify herself as a "scientist." And, not just a scientist within academic settings, but "a scientist wherever I go" since these feelings persisted beyond the normal confines of the academic classroom. Because she felt genuinely connected to and curious about the scientific concepts that she encountered both inside and outside of the classroom, she recognized herself as a science person. She believed that this level of interest could not be achieved without being a science person.

For Lydia, also an engineering major, the thrill of understanding the mechanics behind why scientific and engineering concepts worked was cornerstone to her self-identification as a STEM person:

> I like knowing *how* things work like they were saying but just going beyond that, seeing *how* it works, seeing *how* I can improve it, and seeing how maybe *what if I try this*. So innovation for me is the biggest part of it and that's why I like designing because I get to reinvent something that's already been done and maybe make it better.

In Lydia's experience, developing an identity around engineering is not just about becoming competent in the subject but also recognizing herself as part of the STEM process. Her enthusiasm took her beyond subject competence in which she understood the mechanics of engineering, then pushed her to the next level when she understood how she could, through innovation and design, produce a better end-product.

In addition to the participants' enthusiasm for STEM learning and dedication to persisting through difficult STEM experiences, students within the study also cited the ability to innovatively and critically think through concepts as part of why they considered themselves to be STEM people. For example, Maria, a biology (pre-med) major, recognized herself as a science person as a result of the way that she approaches science: "Being able to be innovative, being able to question…being able to see flaws in things, or not flaws but good things. Being able to have critical thinking." Going beyond mere competence of a subject, Maria believed that the way in which she approached scientific concepts made her a science person. She recognized her ability to innovate, question, and think critically as skills connected to scientists. Through this connection, she could see herself as a scientist. In the future she will remain focused on her goals; her

science identity will provide her the skills and ways of thinking needed to be successful. Nonetheless, she believed herself to be a scientist because she is innovative, asks questions, sees flaws, and thinks critically about issues.

Academic persistence despite struggle. Other students within the study, who self-recognized as STEM people, based their recognition on their ability to persist within their major despite the academic struggles that they faced. Carmen, a mathematics major, believed that she was not a science person academically yet but that she is one in life (as in hypothesizing, way of thinking), for she had that mode of thinking, getting work done, contemplation as well as analysis. She believed that her science identity was developing with more coursework and her desire to explore and understand. She believed that her strong sense of persistence contributed to her sense of math identity:

> I would, but I am always sort of complaining about it and that like totally crushes my spirits, sometimes discourages me, but I think I am a math person because I think it is really fulfilling when I understand certain concepts that I didn't or grasp the concept to solving problems. And, maybe we all would appreciate that, but to keep persisting at it, that is what makes me a math person.

Despite her struggles, which "crush" her spirits sometimes, Carmen recognized that she was a math person because of her continued resilience and interest in fully understanding the concepts that she has worked on. Carmen equates her identity as a math person with the ability to persist through difficult mathematical reasoning without giving in to feelings of failure. Through all of her struggles, "to keep persisting at it, that is what makes me a math person." While sometimes her courses "crush" her spirit, she keeps at it. It is rewarding for her and she believes it will be very useful for companies to have someone like her.

Similar to Carmen, Laris, a biochemistry major, also believed that it was her resilience, which tied her to her identity as a scientist:

> I think that is a big part of it – the resilience of scientist. Which actually if I can go back to the other question, that is also a big part of me – being resilient, just trying. I mean sometimes it is hard to keep a positive attitude when you've failed, but I still find it easy to keep trying and not give up.

Now that she is close to graduation, Laris feels as though she thinks and questions like a scientist, meaning that she has gained the method of scientist thinking and has the ability to break down and analyze the problems that she encounters. Laris moved beyond merely calling herself a science person and recognized herself as a "scientist" within her field. She believed that resilience was a "big part" of her identity as a scientist, even though she admitted that remaining positive was also a struggle. Her ability to remain positive and continue forward enabled to consider herself a scientist. Within this statement, Laris very clearly makes the connection between the fact that scientists are resilient and that she is resilient, demonstrating that she has what it takes to be a resilient scientist.

Ana, an engineering major, also believed that her unwavering persistence had enabled her to be successful in her STEM academic career. She did not give up easily, even though her course of study was challenging. She believed that she must, "salir adelante" (go forward) and be "alto suficiente" (self-sufficient) in all of her endeavors. As she has progressed through college, her science identity has only grown more defined. When asked about whether she considered herself a "science person," Ana explained that she considered herself a science person, particularly around the chemistry discipline. In comparing her science identity development from her freshman year to now, Ana stated that in the beginning she knew she wanted to do science, just not what kind. Now, she

feels more aligned to engineering due to her involvement with organizations and feels as though she is following her passion.

Tatiana, a public health major, believed that she was a science person because she is interested in the scientific view of what is going on around her – to her everything relates to science. When asked about whether she identified as a "science person," Tatiana stated that she does consider herself to be a science person because she studies this area "for the love of it." During her artifact discussion in interview two, Tatiana described how she persisted in her major and intended STEM career path, despite the struggle of an academically rigorous and often unpredictable series of educational events:

Illustration 4: Paints.

> So this is just my travel set of water colors…There's so many things about painting with water color that I think can form some really interesting parallels with my life and my identity. I love the lack of control that you have with them. I think painting in water color taught me a lot…It taught me that sometimes you get—not sometimes, usually, you get much more interesting painting if you just stop trying to micromanage every little detail. If you let the paint flow, and you let it do its own thing instead of, "oh no, the water's going over here," "oh no the water's running into here," you know, water color just runs everywhere. And it's out of your control. The challenge, the reason why I really started it I think is really similar to the reason I wanted to do science and medicine in the first place. I knew it was going to be a challenge, I knew it was going to be something I haven't done before, but I wanted to do it. I wanted to discover in myself

> something that I haven't explored before. Basically, something that's really important to me is developing myself.

Within this explanation, Tatiana compared her academic struggles and identity development to a set of artistic watercolor paints. Within this description, she revealed her belief that academic struggles and identity development often become situations that one cannot control. She highlighted that rather than attempting to control every struggle, one must let some struggles continue in order to understand one's self better and move into the direction that they were intended to move in. She knew that her decision to study medicine would be a struggle, but she accepted that the challenge would be a part of the journey.

Limitations of self-recognition. Some participants, felt uncomfortable with declaring themselves a STEM person or a scientist or engineer, so they utilized modified terms to describe their self-recognized identity. Students also described their desire to push self-recognition beyond merely recognition of themselves as scientists, but to recognize themselves as a particular type of scientist or field expert. In several cases, students chose to modify the way that they self-identified as a STEM person based upon their need for greater experience or additional academic credentials. Finally, students connected issues surrounding loss of science identity with a subsequent loss in their sense of career direction and constructed identity.

For example, Esperanza, a public health (pre-med) major, identified her sense of science identity in the following way:

> Well, it went from like zero to whatever it is now. Literally, because I did practically no science in high school…I wouldn't say I'm a full fledge awesome scientist, but I would go ahead and say I'm a budding scientist.

Esperanza did not recognize herself as a science person before college because she was not heavily involved in pre-college STEM activities. She believed that a scientist is not easily intimidated and is confident in their understanding. She believed herself to be a "budding scientist" because she studied science and was engaging in research to gain a deeper understanding of scientific concepts. Now in college, she identified as a science person, but she stopped short of calling herself a scientist, for she believed that she was merely a "budding scientist" based on where she is at in her academic journey. With more training and a greater amount of knowledge, she felt as though she could eventually call herself a scientist.

Furthermore, Esperanza also wavered on whether she recognized herself to be a science person or scientist. When asked about whether she considers herself a science person, she answered "yes and no," for sometimes she feels as if she belongs because she is more logical than most liberal arts students, and at other times she feels as though she does not belong because she is not scientific or foreclosed to the idea of careers beyond the traditional STEM trajectory. She felt very different than her peers, who were closed off from interests other than medicine. She often felt "diluted" because of her multiple interests and wondered if medical school was what she really wanted.

Other students sought a more defined meaning to their self-recognition as a science person. Ashley, a computer science major, recognized herself as a computer science person but did not want to be called a computer scientist until she declared a focused interest: "I still want to be more well-rounded before calling myself a scientist. I don't want to be just a computer scientist, I want to be a computer scientist that focuses

on this." Although she believes that she is a computer science person, she would like to be more "well-rounded" before declaring herself a computer scientist. Rather than be a general computer scientist with varied interests, Ashley would like to be a computer scientist who specializes in a particular area or making particular programs. Until she gains this focus, she will remain a computer science person rather than a computer scientist.

Finally, within the discussion of self-recognition of Science identity, several students within the study admitted that Science identity could cause issues should their STEM identities ever be challenged. Students had difficulty imagining their lives without their STEM interests and often wondered what they might do, both personally and professionally, if they did not have their current path. Students routinely stated that they could not see themselves doing anything other than being involved with their STEM interests. Cindy, a computer science major, struggled to imagine her existence beyond being a computer science person:

> I have to because I don't know what I'll do or what I'll be if I am not a CS major anymore. That is what I've been doing for fucking years I can't see myself if I wouldn't be doing this at the moment. Like who the hell am I?

Within her interview Cindy related that she was unsure what she might do professionally if she were not a computer science major. Because she has invested a significant amount of time in her computer science identity, she is unsure who she would be without it. Similar to Cindy, Victoria, an engineering major, related a story which demonstrated how fragile her science/engineering identity was in the face of struggle:

> I was like, "oh I am really smart," and then, when I started to struggle in some of my classes I was like, "who really am I?" I was like, "whoa maybe I am not good

> at school, maybe I am not smart." It calls into question who you really are, so it is kind of like a slippery slope…Yeah I feel like it is a really good thing because gives you confidence, but it also makes you more vulnerable and that kind of makes you question…If it is ever called into question where I feel that I am no longer a scientist, I feel that that could really bother me because that is who I am

Despite the fact that she identified as a science person and presented an atomium as a representation that she was a scientist "wherever" she goes, Victoria still faces challenges to her science identity. In the story, Victoria went from feeling "smart" to struggling in her classes and becoming unsure of her ability to feel like science person. She admitted that the connection between her science/engineering identity and her achievement is a complicated one. Victoria related that feeling a sense of identity with her work could be a positive aspect when she understands concepts and has a high achievement level. However, she believed that this identity connection could also make her more vulnerable and bothered should her identity as a scientist ever be called into question.

Outside recognition. All of the participants within this study believed that outside recognition was an important part of their Science identity development process. Most students cited recognition from their STEM community, including peers and faculty, as the most important source of outside recognition. For the students within this study, peer recognition served as a way in which students felt reassured of their skills and abilities and had an opportunity to have their ideas recognized by others in one-on-one or group settings. Students also highlighted unfortunate times when they were challenged by their peers or failed to be recognized by their peers in the academic setting. In terms of faculty recognition, the students within this study felt recognized when their faculty members would discuss future plans for STEM careers with them, take an interest in their

research abilities, or validate their STEM perspective. Others also cited, to a lesser extent, recognition from their family members as a meaningful source of outside recognition, especially when it has been difficult for the student to gain recognition from the STEM community.

Outside recognition from peers. Students within the study concentrated their discussion of outside recognition on the perspectives of their STEM peers. Participants felt positively about this type of recognition when they felt as though their peers could understand their interest and excitement around STEM as well as when they believed that their peers thought of them as STEM people because they trusted their STEM intelligence and abilities. In contrast, participants felt negative effects when peers did not recognize them as STEM people, often forcing participants to feel as though they had to prove themselves in order to become a part of the STEM community.

When asked about recognition from peers, several students noted that they peers recognized them as STEM people due to their deep interest in STEM concepts, willingness to discuss those concepts, and confidence in the student's STEM pursuits. Laris, a biochemistry major, felt as though her peers recognized her as a science person primarily based on the way that she engaged with her course material: "And they see me as a science person because they know that I am always asking why and how like when we study and I guess I make them analyze the material more deeply." According to Laris, her peers recognize her as a science person because she engages with the course material in a meaningful way. Her peers recognize her ability to analyze the material "more

deeply" than others when they study together. Similar to Laris, Tatiana, public health major, also felt that her peers viewed her as a science person:

> And then my peers are all science majors and I'm in there with them, too. Yeah, I'd say that 'yes', people see me as a science major. Because they're willing to discuss science with me. Because they think that I'm up for the challenge of talking about it with them. Hopefully… at least that's what I hope they think. Because Tatiana's peers were willing to discuss science with her, she felt as though they believed her to be a science person. Her peers believed that she was "up for the challenge" of talking about scientific concepts with them as a result of her demonstration of STEM knowledge. However, Tatiana did seem to question whether that was truly what they believed, but she sincerely hoped that was their thinking.

For others, outside recognition represented a sense of trust in the participant's intelligence and abilities. In some cases, participants acknowledged that their STEM peers must have been able to understand how excited the participant became when talking about and engaging in STEM activities. This recognition from peers often translated into support for these students, especially support for future endeavors. For example, Samantha, a human development and family sciences major (pre-med), felt a high level of recognition and support from her STEM peers:

> I guess the people that really know me get to see how excited this makes me feel and how much I love it. And those are usually the ones that support me when I tell them I'm going to medical school. They're like, "Great! You'll make it."

Samantha's peers easily recognized her excitement for the science coursework and labs that they were involved with at the university. This recognition translated into support for her future goal of attending medical school. Because her peers believed in her abilities, Samantha felt recognized within her STEM community. For Emily, a biology (pre-med)

major, recognition from peers was even heightened to the thought that the participant might outperform their peers:

> Well at least among my friends they do. For some reason they always expect me to do better than them. "Oh yeah you're gonna go to medical school" or "Oh yeah you're smart" so I guess because of the degree or I have been following through it because I haven't changed my major. People do see me as that and I guess I do see me as that, too.

In this case, Emily's peers not only though that she was a science person but believed that Emily would outperform them in many ways. Because she has persisted in the major and graduated from the university, Emily's peers see her as a successful peer. As indicated in her last statement, she connects this outside recognition to her own belief that she is a science person.

For Victoria and Sofia, both engineering majors, recognition from peers was paramount to their experiences, proving to them that their peers held a sense of confidence about their engineering ideas and abilities. Victoria related that:

> I can think by myself, critically more independent, but I can also work as a group. I feel that it means that people look at me and have confidence in my intellect. I feel like pride is a very important factor in my education nowadays and very much with me.

People do not automatically recognize Victoria as a science person, because of her outgoing personality, but they realize after talking to her, that she is, indeed, a science person. She believes that the reason that people do not see her in this way is because she is an outgoing female with social skills. Being viewed as a science person is a source of pride for her – people hold her degree in high esteem. Victoria believed that her peers had confidence in her intellect based on her ability to work well within the group setting. She

was able to take pride in this outside recognition, which, given her transition to graduate school during the course of the study, very important to maintaining a sense of identity.

Similarly to Victoria, Sofia, also an engineering major, asserted that outside recognition allowed her voice to be heard within the engineering community:

> I think it's good to bring more ideas too because people will hear you out more and people will be like "Sofia she has a lot of good ideas. Let's get her advice on this" or "This is actually Sofia's idea. Let's ask her about how she thinks we should move forward". I just like seeing that people will include you more I guess.

Because her peers recognized her as an engineering person, Sofia felt as though her ideas were considered by her peers more often and her advice more sought after. Sofia desired the recognition of her peers, even though it was sometimes difficult, particularly with the men in engineering. She believed this recognition to be positive not only for her but also good for the entire group in terms of idea development and group dynamics.

For Monica, her status as a "genius" within her biology lab suggested that she was and had been recognized for quite some time. Even though Monica routinely encountered new problems or complicated tasks, she seemed to be prepared:

> When they said, "Oh my God, Monica's a genius," and they started saying the cricket thing. Today, they needed me today because I was the only one who had taken neuroscience in that class and I knew how to read the graphs and how to put the nerve. I knew how to dissect a frog even though I had never actually dissected a frog before. That was my first time dissecting a frog and I did it right the first time. It's just like a natural knack, I guess. Today people recognized it and I felt really good.

In this statement, Monica acknowledged that the outside recognition from her peers was affirming to her STEM experience. Whether it was the result of her coursework preparation or her having a "natural knack," her peers recognized that she was a science person with a high level of knowledge, thus the "genius" status.

In stark contrast to positive the positive feelings of peer recognition; some students in the study were also influenced by a lack of recognition by peers. Several students within the study were overlooked by their peers either for their inability to fit within the stereotypical look and manner of engineers or by the disbelief that someone such as themselves could persist and become an active member of the STEM community. For Sofia, an engineering major, peers rarely believed that she was an engineering major, let alone an advanced engineering major with a secured job for after graduation:

> I don't think I'm like the stereotypical engineer…I don't think people would assume I would be…Other people probably don't think I am just because no one ever believes me when I say I'm in engineering whenever I first meet them…They're like "No way!" They're just like "You're actually in engineering" and I'm like "Yes I am." I don't know they're just always like in shock.

Sofia cited her appearance, her sorority ties, or and her status as a Latina, as possible reasons that many of her peers refused to believe that she was an engineering major. She admitted to not fitting the stereotypical engineer profile and often shocking peers who do not realize her success within the major. Sofia characterizes herself as not the stereotypical engineer, who is often a male, shy and studies a great deal. Instead, she is a woman who likes to go out, is involved with her sorority, and yet really enjoys the content of her engineering major. Others are often surprised that she is an engineer and have made snide remarks or are condescending in their interactions with her. She is often approached by the men in her program who are interested in a romantic relationship with her, complicating her interactions with peers.

As a biology (pre-med) major, Nelly was forced to overcome the lack of recognition she received from her peers by proving them wrong:

> At first I felt like a lot of people didn't really believe in me, but that gave me the strength to pull through and be like I'm gonna prove you wrong. And now it just makes me feel like I demonstrated to some people who didn't believe in me, that I could actually make it happen. And I did. It was whenever I want to Baltimore, Maryland for my internship, I was a laboratory assistant. I worked closely with one of the PhD professors there. I went to an IA institute in Maryland as well. And when I came back and I told people about that, they were like oh you presented at the NIH? Wow. And I feel like that's kind of where I got a little more value. They really thought of me more as a science person

Because Nelly felt as though her peers were not recognizing her, she decided to prove them wrong by becoming an engaged member of the STEM community. She participated in an internship, worked closely with a faculty member as a laboratory assistant, and presented at a prestigious conference. Only then would her STEM peers give her "a little more value" and accept her as more of a science person.

In focus group two, Lydia further described the role that peer recognition played in her science identity development process. For Lydia, an engineering major, peer recognition is especially important during group projects:

> I feel like you can see it the most when we're working on projects because I've been in groups where one person isn't respected or recognized by their peers; they're kind of ignored in terms of the group project moving forward. But if you are recognized, people will stop and listen, and you can bounce ideas off one another more easily if you are recognized by your peers…I feel like for me it's more like when somebody notices and comes up to me and like, "Oh you did this," and I acknowledge it. Just knowing that someone else looks at you and it kind of reminds me that I'm actually doing something…

Lydia described the positive and negative outcomes related to peer recognition. On the positive side, peer recognition provided Lydia the ability to feel as though she was making a contribution to the projects that she collaborated on. She enjoyed the dynamic nature of exchanging ideas with her peers and recognition of her contribution. In contrast, Lydia highlighted the negative side of peer recognition that can exclude those peers who

are not recognized or respected by other peers. In this case, students may not be invited to actively collaborate on projects or have their voices heard during the group decision-making processes.

Outside recognition from faculty. Although not as salient across the study as the importance of peer recognition, other participants commented on how recognition from professors, was key to students feeling associated with the STEM culture and community. Lydia, an engineering major, considered herself a science and engineering person and she believed that others do, too. Based on faculty members talking with her about future engineering career plans, she believed that they believe in her abilities as well. She also credits herself as an engineering person as she has been doing research with a professor. It was particularly important to gain recognition from the STEM community:

> It is important and you get that validation also from your professors because they show you "This is what you can do with your degree and these are the possibilities and if you think this way and you think of new ideas these are things that you can do" so you get validation from your peers and your professors and just from looking at things around you and understanding how they're working you're like "Hey I actually know what's going on in there."

In the quote above, Lydia, an engineering major, explained how the recognition from STEM peers and professors was essential to establishing a student in the community's norms, thought processes, and environments. Lydia highlighted how validation from STEM peers and professors encouraged her to feel more comfortable in the STEM environment and understand the variety of possibilities for her engineering degree. In addition to the above statement, during the second focus group Lydia further described the nature of faculty recognition as sense of trust and acceptance between student and faculty member:

> Knowing that the professor trusts you and you're responsible of doing your own work and nobody's looking after you and knowing that you do the work and it is accepted or recognized by the professor or by your graduate student, it's very gratifying.

In Lydia's perspective faculty member recognition is built through relationships in which the faculty member is familiar with a student's work and recognizes that work as acceptable to educational and professional standards. In this statement, Lydia described independent nature of work associated with faculty recognition; those who could be trusted to work independently, with little supervision, would garner recognition from faculty members. As a result, such recognition was "gratifying" to Lydia and made her feel a sense of accomplishment and identity around the work that she was doing.

Victoria, also an engineering major, related how faculty members, "can observe you from an objective point of view so they tell you, 'I notice that you like this and this, so I feel that based on my observation you would be really good at this.' She went on to describe in focus group one how one faculty member's recognition validated the years of rigorous coursework and research that she had completed:

> I'm confident in my work, and I know it backwards and forwards, but it all kind of culminated in this moment where I gave a presentation and a faculty member that I really adored his research, came up to me and was like, "I was very impressed by your presentation." I was like, "Whoa, you just said you were impressed by me!" It was amazing; I was on cloud 9. It really validated and justified all those years of hard work.

For Victoria, faculty members represent an unbiased evaluator of her skills; they have the ability to assess her skills and provide guidance to her regarding future endeavors. Even though she felt competent, the recognition she gained from faculty members concerning her research presentation validated her STEM experiences. As members of the STEM

community, aware of the culture and expected level of undergraduate knowledge, Victoria felt as though these faculty members could accurately assess her research capabilities and understand the level of dedication that she had put into her work.

Similarly, Samantha, a biology (pre-med) major, explained the sense of validation that came with a professor's recognition of her intelligence:

> We were doing homework and then they were like, "Well, it's this," and I was like, "No." In terms of what I think, I'm really afraid of being wrong so I was just like, "no". But I said it out loud and the professor looked at me and was like, "Why are you saying it's wrong?" And I was like, "Well, because it's wrong. You have to do this and this and this." And then they were just like, "No, you're wrong," and I was like, "Okay, sorry."
> And then the professor was like, "No. What's your name?" And I was like, "Michelle." He was like, "No, Samantha's right," and then he started explaining what I had just said, and they were like, "Oh, yeah, yeah." And then we had an exam a week after that, and then it was like, "Y'all should do a study group," and we were like yeah we should. And then, "Samantha, you should lead the study group." And that moment was like, "Ah, I am smart and the professor knows my name!" I still have contact with that professor. All that I worked for and all the time that I put into it, it was working out. I was doing something right.

Despite the attempt of her STEM peers to wrongly correct her, Samantha's professor was able to validate her by reaffirming that she was correct in her answer. At this moment, she felt recognized for her knowledge. The professor further recognized her by suggesting that she should lead their study group, even calling her by name. In this instance, the professor not only knew her name but also recognized her for her class efforts.

Outside recognition from family. Fewer students talked about recognition from non-STEM individuals. However, a few participants did discuss gaining recognition from their family members. Students related how their family members recognized their STEM interests, even if they were unsure of exactly what their student studied. Students also

talked about family member recognition when they felt as though they were not recognized by STEM peers or faculty members. Samantha, a biology (pre-med) major, told a story about how her mother recognized her STEM interests when she sent her a picture from her dissection:

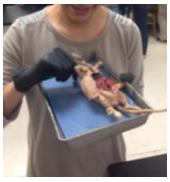

Illustration 5: Woman.

> Yesterday we dissected a rat in bio lab and I was like, "Yes, I'm ready for this!" My mom saw a picture of it and she was like, "You look so happy," and I'm like, "I was so happy!"…That is my science identity. …when I sent that picture to my mom and then she was like, "Wow, you were having fun, weren't you?" And I was like, "Yeah." "Can you see how happy you were with a rat?"
>
> …And I didn't look at it like that way; I just thought it was going to be cool so I took a bunch of pictures and I send them all to them. They were like, "Gross," and I was like, "No, it's really cool!" So it's like, do you see how happy you are doing what you're doing? Do you see how focused you are, how concentrated you are in a rat? And I was like, no but it's not just a rat. You have a heart there and then you have the lungs and then you have…You know, it's not just a rat; it's all the things that come with it. And they're like, "Well I just see a rat, Samantha." So from there I just saw the details in the rat while my mom saw the details in me that I didn't even think about.

Samantha brought the above photo of her dissection to her second interview for the artifact discussion and related the story above. Through this story, one can see that Samantha's mom recognized her as a science person, even when she did not recognize herself. Samantha's mom recognized that unlike most individuals, Samantha looked "so happy" when she was dissecting a rat. As Samantha related, her mom recognized her

science identity by seeing, "the details in me that I didn't even think about." Samantha connected this moment with her mother as a significant event in her science identity development.

For other students, family members recognized their student's general interests as science and math people. Still for others, family recognition seemed to be a welcome change from the lack of recognition experienced in the traditional STEM environment. Tatiana, a public health major, described that, "My family definitely does. I don't think they understand my major, I think they just see me as a science major." In this statement, Tatiana demonstrated that her although her family does not fully understand the coursework and laboratory work associated with her major, and perhaps the long-term goals associated with the field, they did recognize her as a science major. In contrast, for Salma, a nutrition major, the idea of family recognition of science identity stood in stark contrast to the lack of recognition that she received from her STEM peers:

> I'm not sure just because in my lab I work with a bunch of grad students and I don't feel as smart as they do but I'm pretty sure they know I have to do science and math like they do. My family recognizes me as a science and math person.

She was not sure that others regarded her as a science person because they were smarter than her. At times, she has been discouraged by the way that people acted as if they are superior to her, even though she was the only undergraduate student in the lab actually being financially compensated for her research work. Many of her peers were not supportive and assumed that she would not stay employed with the lab for long. In the traditional STEM environment, Salma suffered from a lack of recognition from her immediate STEM community. She juxtaposed the recognition that she received from her

family as a science and math person with the lack of recognition that she experienced in college. Her family represented a group who recognized her as a science and math person when the traditional STEM community in her life did not.

Summary. The Latinas in this study developed their science identities by experiencing self-recognition of their own STEM abilities and feeling recognized by faculty and peers within their STEM discipline as well as their families. For some students this tension of not receiving recognition from the STEM community encouraged them to seek it elsewhere, namely from their families. While the STEM community may not have recognized them as STEM individuals, or perhaps they have not recognized themselves as STEM individuals, their families recognize them and provide encouragement.

Performing Identity: Engaging with STEM Environments

The performance of STEM competence played an important role in the science identity development of the participants. Carlone and Johnson (2007) suggested that: "One cannot pull off being a particular kind of person (enacting a particular identity) unless one makes visible to (performs for) others one's competence in relevant practices, and, in response, others recognize one's performance as credible" (p. 1190). Within this framework, evidence of competence emerged when one "performed" science within the STEM context and was recognized by others for their performance. All of the students within the study discussed various forms of performance that they completed in order to be recognized within their STEM discipline communities.

Utilizing STEM Humor and Allusions. When asked about performing as a STEM person, most of the Latinas in this study commented on their speech patterns and content as evidence of their Science identity. Students specifically noted their sense of humor and how they related a variety of topics back to STEM related aspects as indicative of speaking like a STEM person. Other students believed that their authoritative tone when using content knowledge and their ability to ask critical questions as other examples of their STEM performance.

In terms of humor, Samantha, a human development and family sciences major (pre-med), highlighted her use of chemistry jokes:

> They just take it for granted and I'm like, "Well, think about this." And I usually bring up those chemistry jokes. I make them a lot and they're like, "Huh?"

Although her humor seemed lost on her non-STEM peers, she admitted to repeatedly making these types of jokes regardless of her company. She believed it was simply part of her nature and a way of connecting STEM to her daily life.

For Samantha, a human development and family sciences (pre-med) major, scientific competence allowed her to understand the scientific concepts that undergirded her environment. Even basic concepts, such as boiling water and vapor, incited almost childlike wonder within her:

> The other day, I was with some friends and I was like, isn't it crazy? I had just told them about the water and stuff, I mean, that's a very basic example. And they're like, "Really, that's what you think about?" And I'm like, "Yeah, when you're boiling water, don't you think about that?" And then they're like, "No, I just want my coffee to be ready!" I'm like, "Really? What about those bubbles and that vapor coming out of it? Isn't it weird?"

Samantha related this story as a demonstration of how her understanding of certain concepts has changed the way in which she experiences simple activities. Rather than focused on the sum of its parts, Samantha is interested in the basic biological components that make her coffee possible. Even though her friends are more interested in the end result of the coffee, Samantha became caught up with the scientific concepts behind making coffee. Samantha is more interested than her peers in understanding her world scientifically.

During focus group two, Ashley, a computer science major, described how conversations with her peers are often colored by her references to technology: "I feel like this shaped me. Even though I didn't notice it, when I have a conversation, I bring up technology or something, so I feel like my major shaped me." As she noted, her computer science experiences have made a lasting imprint on her identity and the way that she interacts with others. Even though she did not attempt to divert the conversation towards technology, the influence of her computer science experiences emerged within her speech.

Maite, a biology (pre-med) major, noticed that with her non-STEM peers she often felt particularly "geeky,"

> When I'm talking with my non-science friends, they are—sometimes I say very geeky stuff. I have that—like, I was talking to one of my friends and she says, "Oh, everything goes into a chaos." And I'm like, "Yeah, that's entropy." And she's like, "What?"

Like Samantha, Maite was in the habit of connecting STEM concepts to non-STEM situations, regardless of her audience. Even though her non-STEM peers may not understand her STEM related comments, she continued to use them. Because she was

highly engaged with her STEM content, these connections seemed natural to her unlike they do to others.

Tone and Content of Speech. Beyond humor and STEM allusions, students also noted that their use of authoritative tone and critical questioning demonstrated their ability to perform within the STEM field. Victoria, an engineering major, did not fit what one might think of as the traditional stereotype of an engineer: white, male, introverted, cold. Instead, Victoria is Latina, extroverted, and an extremely warm individual. As a result, she felt like her peers and others in the field did not see her as a science person until she spoke, then they were surprised: "I feel like people don't automatically see myself as a science person but once I start speaking I feel like then they know for sure that I am a science person." Victoria, despite her demeanor, understood how to take an authoritative and knowledgeable stance within a scientific discussion. Although she did not have to change her demeanor, her speech changed to meet her audience and communicate her competence when needed.

Similarly, Laris, a biochemistry major, demonstrated her competence through asking critical questions of her professors, teaching assistants, and peers: "when I ask critical questions they don't tell me like oh you are thinking like a science person or anything but they tell me, "oh that is a very good question!" Her performance of asking critical questions signaled to the STEM community that she was knowledgeable of the content she studied and had the ability to take the subject to a deeper level of analysis. Although she is not outright recognized as a science person, her performance of her competence has been manifested and she is recognized as a result.

In focus group two, Laris, a biochemistry (pre-med major) major, described how the ability to communicate research findings was also an important factor in performing science identity. When asked about whether she was a science person, Laris said that she was because she participated in undergraduate research and was able to communicate those findings. Her undergraduate research began with an early opportunity research initiative, getting her hands on experience, and then her experience was enhanced by her participation in an organization for women in natural sciences that got her even further involved in research opportunities. When talking about her research experiences, Laris, who was otherwise mostly quiet and reserved, became much more animated and authoritative in tone. Laris felt most validated when she completed a lab internship. It was the first time she felt so accomplished because she assisted in the lab, made her own project, and did the work that "true scientists" do. She felt that the effort she applied led her to feel this way. She related that:

> I've identified myself as a scientist. Being able to communicate my findings to other people is part of being a scientist and that's just like anything else. A teacher has to communicate her knowledge to her students; a doctor has to communicate their knowledge to patients, and things like that.

Her authoritative tone and ability to communicate the knowledge that she has built allowed her to perform well in STEM contexts. For Laris, who already identified as a scientist, the ability to communicate findings was an integral part of the work of scientists.

Engaging in University STEM Experiences. When asked about performing as a STEM person, most of the Latinas in this study concentrated their responses on their involvement with projects that reinforced content knowledge and allowed them to

increase their activity in the STEM community. Project involvement consisted mostly of undergraduate research experiences, computing events, and tutoring responsibilities. Most participants cited involvement in research as an experience, which was directly related to their science identity development. Involvement in research was constituted not only by doing the research in terms of performing lab and statistical work, but also in the more social performance of conference presentations. For the participants in this study, participation on a research team was expected almost from the beginning of their college academic careers. All of the participants discussed their involvement with research or their desire to soon become involved with research.

Two students directly acknowledged that participation in undergraduate research was an essential part of pursuing a STEM field, especially within the research intensive culture at the university. Maria, a biology (pre-med) major, realized that she needed to access research opportunities quickly in order to become an active scientist.

> From what I've heard you have to have some type of research done in at least your undergrad or grad year so you can keep being more like an active scientist…I really want to find a research group. I want to find somewhere where I can actually work with the degree I'm working with right now. At least, like, here at [the university], because they say that there are a lot of research initiatives happening here.

According to Maria, a STEM cultural norm exists within her major and field of study, which dictates that students, even at the undergraduate level should participate in research. Even though she did not currently below to a research group, Maria was in the process of seeking out such engagement. She believed the context of the university would provide her the opportunities that she needed in time.

Esperanza, a public health major, echoed Maria's sentiments when she elaborated

on the culture of research within the university's context:

> If you want to be doing research, which I included in my definition of the success of a STEM student, you have to have strong grades your freshman year and pretty much start research your sophomore year. You should start contacting professors that you want to start researching with your sophomore year. Most students are doing it by their freshman year and there's really no place for a students who wants to—it's harder for a student who wants to do research at the end of their junior or senior year…and, if you don't really do research, you're not that respected as a STEM major.

In her statement, Esperanza hits several key points in about the connection between undergraduate research activities and building a Science identity. First, she links the definition of a successful STEM to the performance in the classroom, thus reinforcing that the basis for performance is competence. Next, Esperanza reiterates the competitive nature of STEM research experiences and the need to establish connections early in order to secure these types of experiences. Finally, Esperanza declared that without research a STEM major cannot be respected. As a result, performing undergraduate research for the STEM community is an activity based in academic competence that requires performance in order to be recognized.

Another student, Esperanza, a public health major, directly connected her experience conducting and presenting research as part of her science identity development.

> My science identity… well I presented my research at the conference. That was cool. They picked me. They had a national conference of all the people who were doing research and they picked me to represent the earth sciences. That kind of made me feel good. I was up there with everyone else presenting my research and everyone seemed really interested in it. So it was validating, encouraging.

In her statement, Esperanza described how her research experience contributed to her science identity development. The fact that everyone "seemed really interested" serves as

another element of validation for her science identity, indicating that not only did she most likely seem competent, she engaged with her audience as well.

Victoria, an engineering major, believes that her undergraduate research experience has built upon her content knowledge and enabled her to "be ready for any question that anybody can have." Because she has a high level of competence, she feels as though she is able to answer questions related to her content area or her research interests, without feelings of doubt or uncertainty. Victoria, an engineering major, engaged in research with a faculty member for several years:

> Yeah so it starts off with [undergraduate research] and then my identity developed with it. I feel that I am good at math and science and I feel that I can make a contribution to the engineering community with my research. Yes research was one of the big identity boosters.

Through her statement, she mentions that she can now make a "contribution" to the engineering community since she has participated in research. Salma even acknowledges that this experience was an "identity booster" for her and that it built upon and strengthened her science and math competence.

Beyond undergraduate research, students also identified other project involvement as crucial experiences that informed their Science identity development. Students were particularly drawn to projects that enabled them to perform in front of peers either through collaborative projects or peer tutoring. Ashley, a computer science major, reinforced the concept of performance of STEM activities as a way to define science identity development:

> I mean I was just showing up to class during the project doing the homework, but I would consider myself a technology person when I started in the summer

> learning how to make different applications; mobile apps or a website per say. And then we started going to these tech-a-thons.

She acknowledges curricular engagement as relative, but she focuses much of her time illuminating how engagement in STEM activities has defined her Science identity. Ashley considers her class and project completion merely as "just showing up" and not connected to a Science identity of any kind, but she begins to make those connections to identity when she engages with STEM content in a meaningful way. It is through the application of skills and attendance of events, such as tech-a-thons, that have encouraged science identity development for Ashley. Her engagement in computer science events is a direct result of her participation in two organizations: one focused on women in computer science and another focused on underrepresented minority students in computer science. Through these events, she was able to showcase and enhance her abilities within computer science in the presence of her computer science peers.

Ashley has built a sense of identity within her field by engaging in extra-curricular activities focused on computer science and engaging in an early opportunity research initiative. Her involvement was concentrated in two areas: a computer science student organization focused on supporting underrepresented minority students and a series of competitive computing activities. Her involvement with a prominent computer science student organization provided her a role as a leader and enabled her to engage in mentoring and corporate relationship building events. In addition, her interactions with her computer science peers were usually through this organization because it's harder to make friends in class. Her involvement with competitive computing activities encouraged her identity development as a computer science major, particularly her participation in

hack-a-thons which signaled that she was finally happy in her major. Lastly, her engagement with an early opportunity research initiative provided her the ability to connect with advisors and faculty members and feel a sense of self-authorship over her projects. Her research projects, part of a robotics research track within computer science, focused on artificial intelligence and allowed her to work on her own projects during her free time.

In contrast, Ana, an engineering major, felt as though her Science identity was reinforced through her performance as a STEM tutor for various subjects. In reference to whether she believed herself to be a STEM person, she exclaimed, "Yeah, I think so! Mostly because like besides doing engineering, I am also like working in the STEM field as a tutor." Through this experience, she related how she had the opportunity to display her competence in a wide range of academic subjects to her peers. Rather than merely studying engineering, she was able to perform in front of her peers as an authority on their course content. Ana's science identity was validated further when she felt competent enough to tutor in a variety of science-related subjects. She was told that she was good in multiple science areas, so she should become a tutor. She believed that others, too, recognized her as a "science person" as reflected in her work as a science tutor and the fact that she helps her peers with tutoring as well.

In contrast to these students, the study did encounter one student who expressed hesitancy to engage in STEM activities at the university. Carmen, a mathematics major, purposefully chose not participate in an early opportunity research initiative or the focused STEM freshman interest groups. Even though higher education administrators at

the university designed a multitude of programs and initiatives focused on these areas, she wanted to find her own way and remain open to opportunities and the learning process. In terms of the mathematics community at UT-Austin, Carmen said that she was not active in community groups and was not branching out, with the exception of a women's mathematics and a women's computer science organization which both shared her view of advancing women. Her participation in these women's organizations was primarily about outreach and connecting others to resources in order to make an impact.

Summary. Engagement activities, both curricular and extra-curricular, shaped the performance of science identity development throughout the undergraduate STEM educational experience. Latinas within this study "performed" science through their engagement with various STEM contexts, such as experiential learning opportunities, and their produced deliverables, such as programming and research presentations.

Chapter Summary

Chapter five explored how Latinas in STEM made meaning and developed their science identities during college. While most individuals never think critically about the environments that they live in, the students within this study encountered the world as an amalgamation of scientific concepts and opportunities for understanding those concepts in reality. All of the students within the study connected their identity to a feeling of deep understanding that united their STEM educational lives with their worldviews. Students discussed how additional STEM-related readings and STEM experiences increased their feeling of competence. Several students in the study highlighted the manner in which building competence augmented the way in which they experienced activities as

mundane as walking into a building. Building competence allowed students to live and feel comfortable within a STEM-oriented world by understanding the scientific concepts behind their environment, connecting STEM to their everyday lives, and enhancing the way that they felt about their STEM abilities, especially as they neared or completed their degrees.

Some of the Latinas in this study experienced difficulty developing science identity through the element of competence for these reasons. Students often attempted to tie their level of competence to their grades, but grades did not always reflect the competence level felt by students. Because of this disconnect, these students had some difficulty feeling fully competent in the STEM discipline and possessing of a strong science identity. Furthermore, other students expressed the need for further formalized education or practical experiences in order to feel more competent within their fields. These students attached some meaning to the understanding and knowledge gained within their undergraduate education, but need to have additional classroom, research, and applied knowledge experiences in order to increase their competence levels and move towards a more developed science identity.

Their understanding of understanding of themselves as STEM individuals allowed them to gain more confidence in their STEM abilities and feel inspired to engage in STEM activities and persist within their major. A student's belief in their STEM abilities and perspective coupled with their ability to themselves as science individuals or future scientists, engineers, or in any other STEM careers, enabled students to feel more secure within their majors and develop their STEM identities. Recognition from the STEM

community, rather through the recognition from peers or faculty, encouraged the students to think positively about their own abilities and realize that they have a valid place among the STEM community and within the STEM academic discussion. Even though some participants acknowledged a lack of recognition from the STEM community at times, recognition from that community was paramount to becoming enculturated into STEM norms and typical STEM experiences.

Participants within this study performed competence most often through their engagement in undergraduate research programs (particularly those that involved them in research during their first year) and their engagement with projects that enhanced their navigation of the STEM experience and the building of necessary technical skills. Students highlighted engagement in STEM co-curricular and extra-curricular activities, employment of STEM humor and allusions, and use of authoritative tone and meaningful speech as means of performance within their STEM contexts. Students described the use of humor and allusions as a means of demonstrating their thorough knowledge of STEM subjects and ability to apply that knowledge to life occurrences. Students further discussed their use of authoritative tone and a strong understanding of their STEM content to demonstrate their intellect for their peers and faculty. Such performances enabled students to be recognized by their peers and faculty, thus developing their science identities.

Chapter 6: Gender, Race, Career, and Religion: The Intersectional Nature of Science Identity Development for Latinas in STEM

My primary theoretical framework, Carlone and Johnson's (2007) model of science identity examined the educational experiences of successful women of color throughout their undergraduate and graduate studies. The grounded model of science identity includes three overlapping key areas: science performance (performances of scientific practices, e.g., use of technical terms, tools), science competence (understanding of content), and science identity recognition (self and outside recognition as a "science person"). Utilizing this framework, the findings from the last chapter suggest Latinas in STEM negotiate their science identities through their experiences with building competence, becoming recognized as a STEM "person," and performing their science identity.

This chapter will build upon previous chapters in order to answer the third research question: What is the relationship for Latinas between their science identity and her other identities? Utilizing an intersectional approach, I examined the dynamic interplay of race, gender, and other identities on the science identity development of Latinas in STEM. Within this study, Latinas made sense of their STEM experiences and developed their STEM identities as a result of how their multiple identities were negotiated through their college years. Participants articulated that multiple aspects of identity were salient in shaping their science identity development, including gender, race, career, and religion.

Gender Identity

Participants within this study articulated how their gender identity influenced the way that they experienced and made meaning of their STEM experiences and developed their science identity. The influence of gender identity was most important to the manner in which students made sense of their male peers' perceptions and interactions as well as the way in which they chose to be involved in student organizations.

Latina interactions with men. Building STEM competence was an important aspect of identity development for Latinas in this study, but this has a complicated relationship with the accepted norms around STEM participation and the perceptions of the predominantly male STEM environment. Participants within the study felt as though it was more difficult to build competence within a STEM area because of the traditional norms around the participation of women and minorities in STEM. In addition, perceptions of male peers influenced the way in which the Latinas within this study discussed their STEM competence. Most of the students within the study agreed that feeling a sense of competence was often complicated by the influence of their predominantly male peer group. Participants felt as though their male peers were more comfortable within the STEM environment and often underestimated and actively sought to undermine the capabilities of their female counterparts. As a result, the Latinas within this study underestimated themselves, second-guessed their abilities and actions, and failed to take opportunities in many cases.

Isabel, a human development and family sciences major (pre-PA), felt as though faculty, peers, and others in her field believed women were not as capable of success as

their male counterparts. When asked about how gender influenced her experience, Isabel acknowledged that it was challenging to be one of few women were in her classes and felt as though it was often difficult to relate to the large number of White men in her classes. She maintained that while she has accomplished much for herself, she has also shown society and men in science that she, as a woman, can be successful. If she were a male, Isabel felt as though she would have been more accepted – "oh, they're good because they're boys." She related that professionals in her field believed men were more capable of understanding the often complicated material and remaining in the field; women even if they were currently on the STEM track will, according to these professionals, leave their fields. Elvira related that:

> I feel like for a male it is a little easier because they are accepted in this field. They are good because they are boys, and they believe you are not that smart because you are a girl. Or, you are more capable of doing it because you are a boy. Or, they don't question why you are in STEM they say, "oh ok, you are probably gonna get out."

For Isabel, the competence of her male peers was not questioned; they were accepted without reservation solely based on the gender norms of the STEM environment. The STEM community automatically assumed that she was not "that smart" because she was a woman. Not only do the norms within STEM assume she is not capable of establishing a high level of competence, these norms also assume that she will not persist within the field merely because of her gender. She further notes that the culture around STEM participation suggests that "women are supposed to do this and not that," thus relegating women to a set of gender-normed, non-STEM professions. Because Isabel chose to pursue a STEM profession, she operates outside of society's norms for women.

Maria, a biology major, felt as though men often felt more comfortable in the classroom setting and more at ease with proving their point to her, rather than accepting that she may have had a higher level of competence than they did. She related that:

> I feel like males feel more confident in science and I could see it in the classroom sometimes. Like sometimes I second guess myself before answering, "Oh, I don't know if I should answer." And they're just more decisive and like, "Oh, this is the answer," and even if they're wrong they're going to try and prove they're right. Then I try and tell them something and they're like, "No, you're wrong." And then I tell them again and they're like, "Oh, maybe you're right."

Maria believed that men in STEM were more naturally confident in their level of competence in contrast to women, which caused them to be more comfortable answering questions in the classroom and demonstrating their competence to others. She often felt a hesitancy to answer quickly, thus being relegated to accepting the more decisive responses of her male peers. Her male peers, even when they were wrong, were quick to correct her and often refused to back down from their initial ideas.

During focus group two, Maria extended this idea to challenge STEM faculty members to consider the obstacles that Latinas in STEM are facing within this male-dominated environment:

> I feel like they should give us more credit, or at least more help… I feel like they should give us more credit for what we do and for what we study and for what we're doing with our educational time here because there's times when I feel that I don't fit in because I'm in a class full of guys that are all confident with what they're doing. I'm like, "Well, I don't fit in; I'm just going to sit here in the back." So it's kind of daunting and it kind of just shies you away from the experience because you don't feel comfortable where you are.

In this statement, Maria challenged her STEM faculty to understand and give "credit" to the Latinas in STEM who are persisting in STEM disciplines despite the male-dominant environment. She acknowledged that this environment is "daunting" and often makes her

feel uncomfortable. Only through repeated efforts did Maria manage to see her ideas even considered. She believed that her involvement with biology makes her feel as though she is breaking stereotypes about women and Latinas. Maria says that had she been a man, she would not have dealt with confidence issues and second-guessing herself.

Sofia, an engineering major, stated that being Latina was not nearly as important as the fact that she was a woman. She highlighted several instances in which she felt intimidated or unrecognized by her male peers. She preferred to connect with her female engineering peers on unfamiliar or unclear concepts. In her first interview, Sofia described the hesitation to seek help from engineering peers for fear that she might be considered inferior:

> If I needed help with math or something with homework, I would prefer to ask someone who was a really good friend as opposed to someone I didn't really know because I don't want people to think "Oh she's dumb. Why doesn't she know?" If it's one of your really good friends you know they aren't going to judge you, I guess.

In terms of being a woman, she said that she often feared sounding "dumb." Sofia preferred to seek assistance from female engineer peers who she felt would not judge her for her lack of understanding. She did not want to appear academically inferior to her male peers whom she may have to work with on future projects. Sofia went on to demonstrate the importance of being recognized as competent by male peers and illuminate what happens when one is not taken seriously in this capacity. In focus group two, she described an engineering class project in which the female engineering students were "brushed off" by male peers:

> …We'd been saying an idea since the very beginning. It's a semester long project. And then it kept getting brushed off but when some other guy said, now we're doing that idea but that had been ignored all the way until he said it.

Even though Sofia, and her female peers, had reiterated their ideas to the group, it was only when a male peer presented the idea that her other male peers sought to recognize the idea as valid. Validation could only come from a single male peer, rather than a group of female peers. In this instance, Sofia's female peer group was not acknowledged for their contribution to the group or given credit for where the idea originated.

Within the second focus group, students raised issues around how their competence was often questioned by men, both inside and outside of the classroom. One student talked about how men have doubted her competence within her research lab, however, she's the only one being paid to conduct research. Salma, a nutrition major, described her male peer interactions:

> I was doing a lab during the summer and it was just a bunch of guys and it was me, and for some reason they thought I was really stupid but before the summer ended I got up and told them I was the only one that actually got an award to pay here. You guys had to pay to be here; they paid me to work. We all applied for the same scholarship and I was the only one who got it so the entire time they were thinking that someone was below them or wasn't smart enough, was actually the one person who was probably doing better than them. So I don't know, in that situation, that's the only time I felt really empowered that I had something over what the guys had.

Within this experience Salma was forced to demonstrate her privilege and status over her male peers in order to receive respect in her lab setting. She was forced to demonstrate her privilege and status within a patriarchy-driven culture in order to be validated. As such, non-patriarchal confidence boosters had no meaning in her male-normed environment. Even though she was the only recipient of a scholarship to work in the lab,

her male peers, unknowing of this fact, believed that she was intellectually inferior to them. It was only when she asserted herself as a valued member of the lab that she was able to receive respect and feel empowered.

Cindy, a computer science major, acknowledged that often she was the only female in the class and because of this men either believed her to be brilliant or "stupid":

> Well, I don't think it's much about being Latina. It's mostly also being a girl. You're in classes and it's a big auditorium sometimes and you're one of the few girls. I don't know, sometimes I wish there were more girls. I feel like they either think like, "Whoa, not a lot of girls go into that field; she must be really smart or the cream of the crop," or, "Oh my God she's a girl, she must be stupid or something." So there's just different ways of looking at it that I feel people look at me and I don't like either one. I feel like I'm at their level but they're thinking something way different and I don't like that.

Within this quotation, Cindy demonstrated that women in STEM are essentialized and not forbid from being complex human beings. Here, women are "cream of the crop" or "stupid," never somewhere in between and never anything more complex. Most of the participants within this study agree that their identity as a woman was more important to their science identity development than any other identity. During her interview, Cindy agreed with this sentiment. In her experience male peers felt as though they could classify her in a manner that they felt best on either side of the intelligence spectrum. Their perceptions made Cindy feel uncomfortable within her environment and she wished for more female peers to enter the discipline in order to combat the unwelcoming environment created by male peers

Within focus group one, Victoria, an engineering major, and Cindy, a computer science major, talked about how men tried to spoon-feed them information or shut them down during conversations in order to give them the "right" information:

> Victoria: I feel like what she said also plays out in a lot of the discussions that happen in your discussion sections, at least for my classes. There's been times where I do say something and a guy will be like, "Oh…no, you're wrong; don't say this. Here's the right answer. Don't even worry about answering the second one because I already answered it so you don't have to think about anything." So it's kind of like, the guys try to spoon feed you the answers but it's like, "Well I already know this; I don't need you to be telling me this," and they're like, "Oh."
> Cindy: Yeah, that's super annoying when they baby you. I'm like, stop.
> Victoria: Yeah, and it's frustrating being put in that position where you know you have the potential and you know you can answer questions that you know you know the information but guys think, "No you don't. Here's the stuff, here's the information."

As engineering and computer science majors, these women are in heavily male-dominated fields. Few women, let alone Latinas, enroll and persist through these degrees. According to Victoria and Cindy, the women that are in the STEM context are subjected to male peers who attempt to "spoon feed" information to their female peers and provide them with what they feel are the correct approaches and answers to problems. Men's thoughts and actions are considered superior and women's knowledge is devalued as a result of the patriarchal and sexist structures that undergird these assumptions. These male peers assumed that their female peers are intellectually inferior and in need of help, so they played the role of provider of knowledge, assuming that they knew what was best for their peers.

Because the participants worked outside of these traditional norms of their patriarchal and sexist environment, several students articulated feelings associated with imposter syndrome and doubting their STEM abilities. Despite evidence of their competence, male peers often discouraged the Latinas in this study to answer questions in class, take on highly skilled projects, and withstand criticism. Their sexist male

counterparts instilled doubt within them and actively made the participants of this study believe as though they were not competent in their fields of study.

Ashley, a computer science major, was initially discouraged by her peers from pursuing computer science because she felt as though she was not as skilled as her peers and she felt as though some perceived women in computer science as less intelligent. She referenced the "imposter syndrome" that she sometimes felt and commented on how the men in her major were more expressive and seemed more confident that she did; she felt as though the women were unsure about their skills. Ashley articulated feelings of imposter syndrome as a result of her interactions with male peers. She suggested that women:

> have to do this huge amazing project so we can think we are as good as them…I mean I look at other people who I thought regarded as super smart and I am like oh I've actually done better projects than them and I still feel imposter syndrome.

Ashley felt as though her efforts as a woman had to extend beyond those of her male peers in computer science so that she could demonstrate the same level of competence. She acknowledged that her efforts often exceeded those of her male peers and still remained in doubt as to whether she was as competent as they were. Regardless of her competence level, she remained feeling like an imposter within her field. These feelings of incompetence resulted in her hesitation to take on progressively more skilled projects because she did not feel as though she was ready: "I kind of hesitate in taking a project just because I don't feel I am as skilled or something uh just ah doubt and being hesitant towards taking any opportunity or something." Her hesitation to assume new responsibilities and opportunities was directly related to her perceived level of

competence within the sexist environment in which she operated. Because she doubted her competence level, she was less likely to accept new opportunities, thus limiting her potential for increasing her competence level and connecting her with even more opportunities. Ashley said that she became very aware of how her gender identity was affecting her STEM experiences when an advisor and student organization pointed it out to her. Now she sees the inequities clearly. She says that if she would have been a man, she would feel more comfortable in her major and, potentially take more opportunities.

Cindy, also a computer science major, found herself questioning as a result of imposter syndrome.

> I do feel bad. It makes me question myself, like maybe I am in the wrong field. Maybe they see something that I am not seeing…I mean even the girls I've talked to they have the imposter syndrome, or something that they don't feel like they are software developers, even if they develop software. They feel that way because they feel they are not good enough.

Cindy admitted that she often did question whether she was in the "wrong" field as a result of her interactions with her male counterparts. She recognized that even women who worked in the field still suffered, as she did, from imposter syndrome. Because of these pervasive feelings, Cindy was left wondering if she really belonged in this field.

In terms of gender identity, Cindy believed that the men in computer science perpetuated some of the questioning feelings that she has regarding her STEM abilities. They made snide, unappreciated comments about her abilities inciting feelings of imposter syndrome. Male students attempted to shut down her participation by questioning her competence in verbal interactions. Cindy, a computer science major related that her male peers:

> …have this little talk of "I can do this" or they look at what you are doing and make comments like, "I don't think that is going to work." Maybe is in my head that I think that but that is what I feel - that I am not as good.

Cindy believed the men in her department often made her doubt her level of competence, even though she believed that she was just as prepared and knowledgeable as her male peers. Although the men in her department believed in their own abilities, as seen in their "I can do this" self-talk, they continued to doubt the ability of Cindy to successfully complete her projects. She does not believe that other people think of her as a STEM person because she does not "look" like one (as she put it Asian or White male). For Cindy, gender identity is a powerful aspect relating to her science identity; her experiences are marked by gendered occurrences and an inability to truly fit in with the men in her field, whether professionally or socially.

Victoria, an engineering major, was worried about being treated differently for being a mother of a child.

> truth be told graduate students are perceived as work horses and if you can't give 80 hours a week in lab because you have family commitments that is never looked at positively…Yes I can't give you as much as someone who is single…me who is a single mom, so it's all me, I don't have a partner to depend on to help me out. I feel that, that could prevent someone to work with me because it is a gamble…one thing it's really been on my mind especially moving forward to graduate school where nobody at [my next institution] knows my personal life and that is that I do have a daughter. One, I feel like it is nobody's business, and then, two, I do feel like it could negatively affect me into finding an advisor and being treated like everyone else…I don't want the first thing that they think of as "oh well [Latinas] all have babies at 17 years old."

Victoria expressed her fear of playing into gendered and raced stereotypes that she perceived as inferior to her current status as a Latina in a rigorous STEM discipline. She did not speak up, as she feared reinforcing a stereotype. In her field, she as though she

would be judged as a stereotype of the Latina teenage mother when she felt that she was more than that. Because of stereotype threat, she has become more reserved as a person, as she does not want to be the subject of gossip. She feels like others will judge Latinas in STEM because she had a baby – and, while it is not the way that she wanted to start her academic career, she and her parents have made it work. In terms of her professional life, stereotype threat became an issue in her interactions with faculty and professional priorities. She is fearful faculty will believe she cannot produce at a reasonable level because of her family and that she is a "gamble" whose personal life could be an issue at a later time. She feels as though she may be overlooked for opportunities because others regard her as "busy" with her family or that she will not be given the same opportunities as others. In order to combat this potential bias, her undergraduate research mentor (who is a White woman) has been a source of support throughout her graduate school and career planning. Victoria described, "I am kind of glad that she was more like 'it is not in your head it is a real thing' and so we talked a lot about strategy and how it should come up if it comes up at all." Because her mentor is a woman, she understood the norms of the engineering environment and the biases around women and childcare responsibilities. Her mentor not only acknowledged the issues present within the engineering field, she also taught Victoria how to work within those norms in order to be successful. Her female faculty member did not discuss dismantling those gendered norms, nor did she attempt to have Victoria redefine those norms for herself.

Women-centered student organizations. Gender played an important role in the way Latinas in this study chose to be involved in student organizations. Several students

acknowledged the influence of their women's based STEM groups on their experiences in higher education. Students believed that these programs provided them with opportunities and resources geared specifically for women in STEM as well as allowed them to connect with other women in STEM to support their academic endeavors and inspire future young women.

Sofia felt as though her participation in the Women in Engineering Program was integral to her success in the engineer program. She felt lost much of the time in the beginning and is unsure what she would have done without the built-in support system associated with the organization for women in engineering.

> Actually, after that interview I went and talked to my friends and said "I couldn't describe why it's so important. I just couldn't put it into words" and I asked them if they could explain it 'cause they felt the same way. They said "Just because other people don't understand." It's good to have people that you're comfortable with because you can't really excel or succeed if you feel intimidated or if you don't want to speak out. If you're comfortable with who you're with. I just feel like being around other women is less intimidating. I was able to bring up more ideas or be more comfortable with the environment I was in. If I'm around a lot of guys I do tend to be more quiet and more shy and I don't know, more quiet-spoken I guess.

For Sofia, her male-dominated engineering discipline was intimidating, so she appreciated the built-in support that her participation in the Women in Engineering program provided. While she felt too intimidated to speak out within the traditional engineering setting, she felt more comfortable interacting with her female peers whom she met through her participation in the WIE program. With these female peers, she felt at ease to ask questions, voice her opinions, and share with her peers in an understanding of the struggles that women in engineering face.

Tatiana mentioned that her involvement in Women in Natural Sciences has been a major influence in her experience, providing opportunities and interactions with other women in science. Her biggest takeaway from her involvement with this student group was to understand her opportunities and not allow herself to be held back:

> I think the greatest takeaway from that is that I shouldn't feel that I'm getting held back because I'm a woman. Even though there are many instances where that does happen, I feel that if you surround yourself with a community of people who understand the importance of women in science, that you can still make it.

Her involvement with this organization has kept her very active, meeting people, and connecting to opportunities. She has had the ability to connect with other women in science who share similar struggles but who are also pressing forward with their educational goals. It has been a four-year long program in which she has had the ability to travel with other young women in the natural sciences and form bonds with them. Through her involvement, she also had the opportunity to mentor and tutor other women in natural sciences as well as gain the opportunity to be employed in the organization's office.

Racial Identity

The study's participants described how their identity as a Latina influenced the way in which they experienced the STEM context within the university and developed identities around their STEM disciplines. Although all students felt as though their gender identities played a larger role in the way that they made sense of their STEM experiences, the participants also described how their racial identity helped to construct their experiences and shape their science identity. The Latinas within this study often had difficulty feeling a sense of belonging within their STEM environment. Students who did

successfully navigate that environment felt as though they were breaking stereotypes for Latinas and building a sense of confidence about their knowledge and skills. The students within this study also highlighted how their racial identities had a profound impact on the way in which they were involved in student organizations on campus. While searching for a sense of belonging within the STEM context, Latina/o-based STEM organizations enabled them to build a network of support with other Latina/o students and build a sense of community. Finally, participants commented on their worries about how others might view their race as an unfair advantage or how they might be utilized to fulfill quota requirements for diversity.

One's place in the STEM community. Participants emphasized how their identity recognition was influenced by the way in which they perceived their inclusion within a STEM field. Because Latina/o STEM students are not in the majority, outsiders often do not equate Latina/o identity with a student who studies within a STEM field. Students not only experienced difficulty "seeing" themselves in STEM disciplines but others also had difficulty recognizing them as part of the STEM community. In many ways, this inability to build self- and outside recognition of one's Science identity was directly tied to the intersectional nature of their racial and gender identities with their science identity development. The ability to find one's place in the STEM community was complicated first by one's status as a woman, and then additionally complicated by one's status as a Latina woman. As Samantha stated in focus group one, "I feel like we're like the rare thing, you know…We're the unicorns in STEM! We're double minority. We're women in itself, and then we're Latinas." As one student, Emily, a biology major,

recounts: “a lot of the times I’m kind of classified as a Hispanic, a person who doesn’t do these type of careers. Like science-y careers, or chemistry, or human bio.” Even though Emily identified strongly as a “science person,” her science identity remained influenced by the way in which outsiders tended to *other* her as a part of the STEM community. Her experience highlights how participants made meaning of their science identities as a result of the predominant narrative surrounding who is traditionally part of the STEM community (citation needed). In terms of class participation, and potential identity validation, Emily, went on to admit to little engagement with her professors or peers:

> To be honest, Latinos or Latinas that I’ve had we don’t really talk whenever it’s in class unless the people are really talkative…A lot of the times it’s that particular white guy or Indian guy that’s talking. It’s weird for me sometimes because they’re surrounded by their own people it’s just different.

Emily directly connects her lack of participation within the class to the lack of Latina/o representation with the class. Because she is surrounded by individuals who are unlike her, male and non-Latina, she feels uncomfortable speaking up in class. The white and Indian men in her class make up the dominant majority while Latina/os were underrepresented.

As a computer science major, Ashley had similar experiences regarding her science identity development. Often times, it was difficult to “see” herself as a computer science major, with the same level of competence, because she was one of few women and even fewer Latinas:

> I mean even as a women in computer science you do feel the sense of not perceived as smart sometimes or I felt it and I mean you throw the whole minority thing and I mean you’re surrounded by – during my Freshman Research Initiative class I mean it was probably 70 percent no it was all white, Asian, and Indian

> except I was actually the only Hispanic in there, and there were only three girls in there.

Her identity development as a computer scientist is mediated by the fact that she is a woman of color. Ashley's perceptions of herself as a "minority" in her major, both as a Latina as well as a woman in general, affected the way in which she experienced her undergraduate coursework and STEM related activities. Whether real, or imagined, the lingering perception that she is not "as smart" as her Asian and White male counterparts emerges as a salient part of her experience.

Another participant, Lydia, an engineering major, noted how due to her race and gender she was not generally considered an engineering person:

> I think it's rewarding and just being an engineer, people look at you differently. In that sense it's nice but just knowing that you're in engineering and you're finishing engineering. People I think do look at that especially because you're a girl people don't expect you to be a Latina girl who's an engineer. They do look at you different…

Lydia's sense of identity around the study of engineering is connected to her other identities, her femaleness and her *Latinidad*, or feeling of connection to the Latina/o community. She acknowledges that "people look at you differently" and that her experience is mediated by the fact that she holds this other identities simultaneously. The "people" that she referred to in this statement are primarily made up of her engineering peers, but she also extended these ideas to include faculty members and potential engineering employers. She is instantly set apart by society due to the demographics of her field thus making her science identity, and subsequent achievement in graduating from this field, viewed in terms of her multiple identities.

For several students navigating the STEM environment successfully meant breaking stereotypes and gaining a sense of empowerment. During interview two's artifact discussion, Laris, a biochemistry major, presented the following picture:

Illustration 6: Toy.

> It is a mariachi girl I picked it because it is a symbol of being Mexican, and it is a symbol of feminism because there are not that many mariachi women and being one is unique, and that is how I feel about myself sometimes.

Her choice to include this mariachi girl as a salient part of her identity revealed several how her science identity development came at the intersection of her Mexican and gender identities. She recognized that her racial identity was important to her science identity development; however, she extended that description to illuminate the fact that her gender identity was closely intertwined with racial identity's influence on her science identity. She likened herself, as a woman in STEM, to a woman in mariachi. Like women in mariachi, she is one of very few women in STEM. She directly states that this artifact is a "symbol of feminism," and that she feels connected in a way to the struggle of the mariachi woman.

Maria, a biology (pre-med major), by majoring in a STEM field, felt as though she was breaking down traditional stereotypes about Latinas.

> I'm actually breaking the stereotype of being a Latina at home taking care of family and stuff like that. It just makes me feel more empowered doing science and training to be a doctor. I feel like I am breaking barriers because there aren't that many women, at least that I know from like my family or from high school and stuff, that are pursuing a science career so I feel that I'm kind of breaking that idea of not doing science.

For Maria, the traditional view of Latinas as homemakers stands in stark contrast to the path that she has chosen. Even though she did not know anyone from her immediate circle pursuing a science pathway, she is empowered by her choice to study science and proud of her ability to break down the barriers for other women who may want to take a similar path.

Beyond stereotypes, some students further extended the identity development element of competence by connecting elevated competence to an elevated status within one's environment. Because students felt more confident in their level of competence, they also felt as though they had more ability to voice their opinions in conversations related to STEM. This was particularly important when the students within this study felt themselves pitted again individuals from dominant groups within STEM (e.g. white peers or men in STEM). One example of this connection involved Emily, a biology major (pre-med), who felt as though gaining a high level of competence enabled her to speak knowledgeably to those who, under different circumstances, might have challenged her authority on scientific concepts. Emily related that:

> I feel now whenever I speak to somebody who's a white person or another person who's not from my race, I feel like I'm competent. I feel like I've created an identity now…not only being a bio major, but a bio major at UT and graduating with it. So, I feel like yeah, I feel more competent, I feel like secure…I feel like I gained a step in society. I feel like I can't be looked upon like I don't know.

Specifically, she highlighted that she is now, as a biology graduate of a top tier research

university, able to speak with confidence about STEM issues, as she feels more competent and possesses greater sense of her scientific identity. In her case, an elevated level of competence allowed her to "…feel like I'm competent. I feel like I've created an identity now. " This sense of identity provides her the confidence, even in the presence of individuals from dominant groups, to have a voice in scientific conversations and feel as though she has the needed competence to speak knowledgably on these subjects.

Latina/o-centered STEM student organizations. The students within this study also highlighted how their involvement with Latina/o-centered STEM student organizations nurtured their science identity development. From these organizations, students were able to find their niche within the STEM community and build a sense of support among their fellow Latina/os in STEM. Isabel, a human development and family sciences (pre-med) major, related that in terms of student organizations, she was involved with a Hispanic Health Professions Organization. She felt that through her involvement, it was comforting to "see" other Latina/os and build connections to other Latina/o peers and professionals.

> I liked the Hispanic health professions and that one in particular I stuck with since freshman year…I don't really get to see a lot of Hispanics in my classes and almost everyone in my classes is pre-med, pre-vet, pre-PPA almost every one of us is in STEM some way or another, so you get to see other people…[and] Like those doubtful days and I think it is important to know that you have someone in the same boat that is like let's just do it, and it is different because I really like that you can do it in the organization.

She mentioned that her peers within the organization are supportive and able to open other doors. In terms of the aspiring physician's assistant organization, she appreciates how everyone is taking similar classes, visiting PA schools, and forming study groups

and socials. Finally, she noted how even in times of doubt, her participation in the organization allowed her to understand and be comforted that others were "in the same boat" as her as Latina/o students, most of whom were first-generation college students.

In a similar way, Lydia, an engineering major, found that her participation in a Latina/o-based STEM organization allowed her to connect with Latina/o peers in engineering, especially her Latina engineering peers. For her, the Society for Hispanic Professional Engineers allowed her to meet some of her "best friends" and other Latina/o professionals during her college career.

With her general involvement as president, she has found that it is a community of Hispanic engineering majors that are like her "family."

> We always have the tagline of "SHPE Familia" just because it's hard to find a Hispanic community within STEM so knowing that it's your support system that you didn't bring to college there for you. So yeah we always talk about our SHPE familia atmosphere.

Her involvement with SHPE was also an opportunity to hear from other Latinas in engineering through SHPE's Latina subgroup, *Señoritas*. *Señoritas* is a group of engineering women within the organization, and Lydia has found a support system within these women where they talk about classes, commiserate about coursework and projects, and inspire each other.

> It was really exciting because I came from not knowing anybody who wanted to do engineering – specifically girls – to going to this organization and seeing so many girls who were doing engineering who were Hispanic just like me. It was really exciting. They actually have a program within SHPE called SHPE *Señoritas*, which is specifically for the girls in retention program for Hispanic girls. That was a big part of it. It's hard and you sometimes don't know who to go to if you have a question or if you have a problem if you're thinking about "Do I really want to do engineering or do I want to keep going?" It's hard because I don't feel like you have a lot of people to go to and ask questions about it, so

> that's definitely hard. The people who are girls and are in engineering we kind of look for each other.

Señoritas provided Lydia the ability to see other Latinas interested in engineering as well as the opportunity to engage with a supportive community of her Latina peers. Lydia's involvement with *Señoritas* went beyond merely interacting with Latina/os in engineering but became more specific to supporting and being supported by her Latina female engineering peers. In this way, her experiences with the student organization represent an intersection between her racial and gender identities and the influence that this experience has on her science identity development.

Evaluation of knowledge and skills. When discussing their achievements and future plans, a couple of the Latinas in this study voiced their concerns about the evaluation of their knowledge and skills might be influenced by their racial identity. While each of the participants acknowledged the racial and gender gaps in their field, each of these participants demonstrated how their racial and gender identities may play into the way that they are seen during the academic journey and during the hiring process. Victoria, an engineering major, was concerned that race and gender politics would overshadow the valuable work that she had done in her field, making her known more for being a Latina in STEM rather than an engineering asset:

> here's the thing. Yeah, I got into grad school. Yeah, in a predominantly white male institution and field, but I've called people out because they're like, "Oh you're a Hispanic female in STEM, you're going to make so much money, everyone's going to let you." And I tell people, "Don't discredit what I've done because of the color of my skin or my background." And then I get really upset and they usually don't understand why and it's exactly how you guys are like—it does make it seem like they devalue you, but at the same time I'm not going to hide behind the idea that that wasn't taken into account. If it was fine, if it wasn't, okay. But I am very upfront about my culture. And I also feel like I'm kind of

> whatever works because I know I'm on par with everybody so either way. I mean, all you can do is not let people bring you down.

Victoria acknowledged that her race and gender identities have been a factor in her success. However, she is quick to point out that her value as a STEM professional should not be solely based on those identities.

Similar to Victoria, Ashley, a computer science major, indicated that her Latina identity made her doubt her competence, as she was afraid that there might be quotas associated with internship opportunities and hiring:

> And only the women or the minorities get to go. Or even some, they were kind of backfiring just—even when you get an internship or an interview or an internship offer. I mean, you're kind of left doubting. Is it because I'm a woman? Is it because I'm a minority? I'm left with that thought. I mean, I'll never know if I got it because of my skills or because they're trying to fill a quota.

Because of this, she notices that recruiters are more pleasant to her, but she also tries hard to prove herself to others as a result. She acknowledges that if she were White, she feels like she would be evaluated on just her skills alone, rather than the combination of her identities and perhaps to fill a quota:

> If I was white, yes. If I was white I would know for sure that they would be interviewing me simply for my skills and not just to meet quota. And I would be able to fit in more and people would perceive me as more of a computer science student.

Within this statement, Ashley connected her racial identity to a fear of not being equally evaluated against her peers. She fears that because she is Latina, she will not be evaluated on the basis of her skills but that she may be used to meet a diversity quota. Her fear was exacerbated by her desire to "fit in more" and be perceived as more of a computer science student, rather than be defined by her racial and gender identities.

Career Identity

To a much lesser extent, Latinas within the study attached various meanings to their STEM experiences, both inside and outside of the classroom, based on their career identities, aligning future goals and the ability to give back to their families and communities as key markers for understanding their science identity development. Students most often connected their science identity to a type of humanitarianism or practical application identity. Most participants, like Tatiana, a public health major, indicated the need to improve the world around them: "I have such a passion for improving help and I feel like that's reflected in how I chose my major and I'm kind of choosing my path career wise and professionally." Tatiana defines her science identity through her future plans for improving public health. Her "passion" for the future helps define her identity as a STEM major.

Career identity aligned with a broader social impact. Ashley, a computer science major, also mentioned her desire to pursue a career beyond the traditional computer science industry to be an important part of her identity. Science identity linked with a humanitarian identity comes in stark contrast to the industry driven goals of her mostly male peers. In interview two, Ashley brought the following artifacts to describe her identity:

Illustration 7: Sign.

> I always wanted to do something with my major where I can help people. Where I mean we talk about all these real world problems, developing countries, but I didn't realize how much I could do… with journalism I didn't' know how much I could do or even if I was to go into something such as international affairs, I mean you learn about the issues but, you don't really have something concrete such as a tool…my ultimate goal is to make a social impact in CS and they don't show you how to go help a non-profit…I feel like I have to pave my own path so I need to start now. I mean it really changes the perspectives about the world and that was a good thing because I used to think that I was going to be in a cubicle coding all day. And then it showed me oh you can actually go anywhere and help someone I mean I don't know how exactly but just helping someone.

For Ashley, the desire to make a broad social impact will utilize the knowledge and skills that she has amassed during her STEM education. As she mentions, because this is not a traditional computer science path, she must "pave her own path." Ashley stated that her computer science peers were a bit close-minded about the uses of computer science, choosing not to discuss computer science and non-profit collaborations, but she is looking to integrate her interests. She wishes to stay informed and stay well-rounded, surrounding herself with people from both worlds. To her being well-rounded means knowing current events, being globally focused, and striving for a social impact for more than first-world problems.

Cindy, also a computer science major, related, "I also want to aim it more

humanitarian I just don't want to be in the industry." In focus group one, she further elaborated on this point:

> For computer science, I like it. I like the problem solving aspect, I like that we get to go to build anything, essentially, we want from an app to a website. I think computer science right now is geared to very dumb solutions, not actually real world solutions like engineering and that's what could change in computer science. And I mean, even our research. I did research on artificial intelligence and even though we were just doing a basic game, the actual technicalities was in and you could apply to anything from autonomous vehicles for the blind, or who knows how many car accidents we could save or reduce if we had autonomous vehicles or something like that. So yeah, real world solutions.

For Cindy, computer science lacks real work application and a problem-solving purpose. She would like to transfer the skills that she has learned in computer science to make a broader social impact, rather than contribute to solving "dumb solutions." Her alignment with this goal of broader social impact and a humanitarian identity comes in stark contrast to her computer science peers and influenced the way that she developed her science identity. Her science identity developed through its intersection with her career identity.

Career identity aligned to healthcare. Similar to Ashley and Cindy, Isabel, a human development and family sciences major, felt a strong sense of humanitarian identity that intersected with her science identity development. She related, "I am blown by science and just feel science helps solve a lot of problems in the world and so I would really want to be a part of that." Her science identity has developed around her desire to utilize science in order to meet the needs of the world around her. Not only is she interested in the field, but she has a desire to apply that interest where it is needed, especially in Latin American countries. During interview two's artifact discussion, Isabel

brought the Honduran bag below as a representation of her identity. She related that the bag represented her Latina identity, as one of her parents is Honduran, but that it also had a much more important meaning:

Illustration 8: Fabric.

> I feel like we look at the big picture with STEM you are able to do a lot and use what you learn and impact the world than in another profession…And if it's like sometimes when I am struggling in class I am like oh yeah but you want to go to Honduras and have a clinic over there you think that if you don't do it now if you can't even handle physiology so that is kind of like my pep talk to myself and just kind of like this is my big picture and it kind of just helps me motivate myself and I mean I wouldn't be able to impact this community if I wasn't a STEM major, I mean I could go and build houses but it wouldn't be the same as if I was like you know because I am a STEM major I could really go and do it for my community that is one of my goals.

For Isabel, the bag represented a humanitarian career identity associated with her future work in Honduras. As a result of her STEM focus, she felt like she could see the "big picture" and was motived by her desire to give back to Latin American countries in the form of a career in medicine. Her racial and career identities intersect to inform the way that she thought about her STEM experiences, including her struggles, and the way that she viewed her future as a health professional.

Laris, a biochemistry major, defined her science identity development by her desire to serve the healthcare needs of impoverished countries. In the future, Laris will utilize her knowledge of medicine to improve access to healthcare for Latin America:

> I want to help in extending the services to impoverished areas…long term goals for me are helping developing countries in health care and this could mean from developing a vaccine for worms or just increasing the access to communities in developing countries…
>
> I guess as a medical doctor I hope to set up a clinic in a developing country, or clinics. But I see myself doing a lot of service to the community in terms of health care, and hopefully in Latin American populations. [focus group one]

Through her participation in the interviews and focus group one, Laris demonstrated her long-term goal of serving the healthcare needs of Latin America. Her current coursework and educational choices were defined by future career choices.

Similarly, Maria, a biology (pre-med) major, described her career identity during her artifact discussion. This picture of the medical school located in in her hometown signified her career identity alignment with the healthcare field and desire to serve her Latina/o community:

Illustration 9: Building.

> I really want to help out my community. I really want to help out where I grew up. I want to help out El Paso and I want to study medicine in El Paso so I can

> help out other community members. And just start knowing a lot of community services and programs in El Paso while I'm studying so I can be like, "Okay, after I become a doctor I can do this, I can help out with this organization, I can help out with this and that, I can work at the local hospital."…That's the challenge because I want to do this, something selfless, but I also have to think about all these loans and this money that I'm going to have to pull out.

Maria identified this artifact as a representation of her healthcare field career as a significant part of her overall identity. She clung to the idea that she would return to her community to utilize her skills and serve the people there. Her altruistic desire to server her community, however, is complicated by the level of debt that she must go into in order to attain her medical degree.

Need for interdisciplinary career. In terms of an interdisciplinary-focused identity, one student expressed how they identified with the need to integrate multiple interests, both STEM and non-STEM into their experiences and future careers. Esperanza, a public health major, explained during her artifact discussion that her varied interests influenced the way in which she pursued a STEM major and constructed her idea of what a meaningful career might look like:

Illustration 10: Poster.

> I would read all of these different magazines, not cover to cover, but I would read a lot of the different stories and see that it was a very natural way to kind of see what you were drawn towards. Because you know, you have a magazine full of a lot of different topics and it was easy for me to see that I actually cared about certain issues in global health and development. I was interested in a lot of them, but I was most drawn to stories about people who were really making a difference in those areas…It just represents how I have really, really, diverse interests. I don't feel like I fit into any clear molds…Sure! I try to make them converge. That's basically what I'm doing when I'm thinking about what I'm going to spend my time in. I realize there are all these things and there's only so much time, so I really try to combine them.

Esperanza described this magazine artifact as a representation of her spectrum of interests along the STEM and social impact continuum. Although she was interested in a variety of topics, she continued to be interested by those surround the many ways in which one can "make a difference" in public health. Her diverse interests translated to a need for an educational pathway and career that was interdisciplinary. This participant desired to see her wide range of interests present within her coursework and future plans. Esperanza stated that:

> It super relates to my scientific identity that the kind of science I want to do which

> is tropical medicine is so interdisciplinary, and I feel that I'm really interdisciplinary, and I like lots of interdisciplinary things. So I think I found a field in science that would allow me and actually need me to bring in all of these things together, which is what I enjoy doing and what I think I'm good at.

Esperanza's science identity has developed in tandem with her interdisciplinary identity. Her varied interests and desire for an interdisciplinary career path make her distinct from other participants who took a more traditional pathway.

Religious Identity

Students within the study also discussed how their religious identity intersected with their science identity development. For most of the students, religious identity and science identity reinforced each other, with scientific concepts proving the existence of a supreme being and religious concepts inspiring an admiration of science. However, tensions existed when norms within these identities came into play, such as when religion dictated against certain scientific concepts (i.e. stem cell research).

Isabel, a human development and family sciences major, brought the pictured cross and scripture necklace as a representation of part of her overall identity in the artifact discussion:

Illustration 11: Artifact.

Isabel also highlighted how her religious identity has been influential to her experience. She was raised in a Christian household (non-denominational). She stated that although religion comes first, science helps her faith. The body reflects a perfect system, and that perfect system could only come from a higher power. She realizes, through science, how great God is and that everything perfectly fits together. She wants to have her life planned but cannot, and she has to remember to trust God. Her religious identity affects how she treats other people and makes decisions; it also keeps her humble – regardless of where she gets.

Victoria, an engineering major, when asked about other identities which might be highly influential to her experience, she mentioned her religious identity. She acknowledged how her religious identity and science identity intersected:

> I feel like sometimes you read about stuff in the bible and you read about how good God is and when you are in science class that is when you kind of realize how great God is because of what He has done in science…it couldn't of been just like chance this could of just happened there must have been an artist doing it to make this work so perfectly so I feel like that is one of the reasons why science reinforces our identity.

Here, Victoria remarked how her knowledge of scientific concepts impressed her to the point that she knew that these concepts could not be by chance and that they were derived from her God. She felt as though the connection between perfect construction and science reinforced her science identity. However, she did also mention that her scientific research at times collided with the beliefs of her religion, thus compromising the relationship of the two identities:

> I know that as a Catholic, I'm not really supposed to encourage or promote the use of embryonic stem cells, but I feel like if that's where we need to go to save people then that's where we need to go. I feel like a lot of people could easily turn

> that around and call me a hypocrite, or that I'm being a cafeteria Catholic. And I'm like, "Well," and then that's when they're calling in to question my Catholic identity versus my Science identity. I mean, I feel like in general I don't really care what people think because I'm going to do whatever I want to do. But yeah, it kind of just bothers me…

Because Victor is Catholic, the research that she conducts is not condoned by her church. This caused some tension within Victoria that she could not reconcile. She believed that research was moving in this direction for the better, but she knew that her religion would not condone the move towards this type of scientific discovery.

In addition, Victoria felt some tension between her science identity, Catholicism, and the intertwined nature of that with her Mexican culture. She finds herself small and afraid when in contact with elders or people of authority, such as professors. She does everything possible to maintain a certain level of respect. This can often be a source of anxiety when she must disagree with others, such as professors (both men and women). She observed that in Latino culture, a woman is told to "make yourself smaller." She has noticed this stands in stark contrast to her peers who easily maintain casual relationships with their professors. For example, Victoria's peers easily refer to their professors by their first names, whereas Victoria feels she needs permission to do so because otherwise it would be a form of disrespect.

Cindy, a computer science major, felt a similar tension within her own identity development. During her artifact discussion, she brought the picture below of the Virgin Mary to describe the importance of her religious identity:

Illustration 12: Religious Art.

> Technology and spirituality technically don't go; I feel that a lot of people are atheist and stuff, and you know this just proves things, but no I mean it is more connected, it is connected if you think about it! …Sometimes I am creating a program and I think is this how God felt when he created us? I mean I believe in evolution, but I also believe in God and I don't know how to combine that…I don't know if I am cheating God or nature but I just think I am enhancing it.

Cindy discussed the picture of the Virgin Mary and her Catholic beliefs recognizing that often issues like evolution create a rift between her science identity and religious identity. At times, she felt as if the ideas might be able to be reconciled and at other times she felt as though they could not be reconciled. In order to reconcile these identities, Cindy believed that she was "enhancing" here world, rather than believe that she was compromising her religious identity.

In focus group one, a lively, extended conversation developed regarding the ability to reconcile one's religious identity to one's science identity. Students described the underlying conflict between the two identities and acknowledged that one's science identity could either reinforce or destroy one's religious identity:

> Maite: Yeah, I mean, it's part of being a scientist. You question, it's why? It's—
> Salma: There's this underlying conflict.
> Samantha: Like I always tell my mom, "Mom, do you know like this and this and this," and she's like, "No." "Do you think God made it?" "Of course,

Samantha! God made everything!" And I'm like, "Are you sure?"
Victoria: I've had the completely opposite reaction, where you're like doing physiology and I'm like, it's so elegant, it's so precise. It has to be God, like, there's no way.
…
Isabel: I feel like STEM has helped me reinforce my beliefs.
Cindy: Yeah, I feel more connected to everything.
Isabel: I'm like, dang, praise you Jesus! Because I'm like, dang, you did everything so perfect and I don't know. I mean, I feel like I've never really questioned God and evolution—the whole thing I'm like okay yeah whatever. If I have to learn it, whatever…
Samantha: It's so much and even the things that we don't know yet but still exist, it's like, "How did you think about that?"
Victoria: Just when it gets real hard you're like, "You could have made this a little bit simpler."…Just a beautiful, elegant machinery…Because they're like, "STEM made me realize God isn't real," and I'm like, well, that's really extreme but I'm like, that's cool. But I just went the other way.

Throughout this conversation, some students such as Victoria, Isabel, and Cindy appear to reconcile their science identities to their religious identities. They believed that through their study of science they felt a stronger sense of religious identity. Other students, like Maite, Salma, and Samantha acknowledged the tension that they felt between the two identities, and their inability to reconcile many of the scientific concepts with the religious teachings that they were brought up around.

Chapter Summary

All of the students in this study felt as though their identity as a woman influenced the ways in which they were perceived in terms of intelligence and ability in addition to the way in which they interacted with the STEM community both in and outside of the classroom. Because they were Latina women in a traditionally White male STEM environment, they often harbored feelings of imposter syndrome or fear that they might fall victim to stereotype threat.

This traditionally White male environment perpetuates a culture that devalues women, stereotypes women, and belittles women in order to maintain power structures that benefit men. Students also described how male peers created a uncomfortable environment for female peers making it difficult for the students of this study to seek help from peers or faculty for fear of seeming intellectually inferior. Student participation in women-centered STEM student organizations provided built-in support and connections to other STEM women, enabled greater help-seeking capabilities, and pushed these women towards achieving their goals.

For the participants of this study, gender identity influenced their college STEM experiences in a variety of ways, ranging from their interactions with both male and female peers to the way in which they participated in STEM activities and student organizations. Racial identity influenced the way in which students made sense of their place among the STEM community, became involved with student organizations, and considered the implications of affirmative action or diversity-based policies. Career identity influenced the educational decisions and pathways of these students during college and pushed them towards their ultimate STEM career goals. Religious identity intersected with science identity for the way in which the Latinas in this study, most of whom identified as Catholic, made sense of scientific concepts and reconciled their research with their religious beliefs. The way in which these students attached meaning to these experiences influenced the development of their science identities.

Chapter 7: Discussion and Conclusions

Latinas are entering institutions of higher education at greater rates than ever before, yet they experience lower completion rates and are more underrepresented in STEM careers than their peers. According to a compiled report of national data from *Excelencia* in Education (2015), fewer first-year Latinas reported the intent to major in STEM science and engineering fields and Latinas represented a smaller percentage of women earning STEM bachelor degrees and entering science and engineering occupations. In 2012, 37% of Latina freshman at four-year colleges indicated they intended to major in science and engineering fields whereas 48% of their male counterparts indicated the intent to major in these areas (NSF, 2014). Overall, Latinas represented a small percentage of all women who earned bachelor degrees in STEM, with 8% of all women who earned bachelor degrees in STEM being Latina as compared to Whites (61%), Asians (14%), African Americans, (9%), and others (7%) (NCES 2014). Latinas who did earn bachelor degrees in STEM disciplines were concentrated heavily in biological and biomedical sciences (57%) rather than in engineering technologies (2%), mathematics and statistics (7%), or the physical sciences (9%) (NCES, 2014). Finally, Latinas with STEM degrees have lower representation in science and engineering occupations and are less likely to work in these fields even when they have their degree, in comparison to their Latino male counterparts (19% Latinas, 37% Latino males).

This phenomenological research study explored how undergraduate Latina students in STEM made meaning of and developed their science identities. Despite the understanding that women of color are simultaneously put at multiple intersections of

oppression, including racism and sexism, few studies have explored these experiences (Carlone & Johnson, 2007; Collins, 2000; Ong, et al., 2011; Riegle-Crumb & King, 2010). This research, framed by Carlone and Johnson's (2007) model of science identity and Crenshaw's (1991) theory of intersectionality, explored the science identity development of Latinas in STEM disciplines as well as examined the multidimensional nature of this development. The research study was guided by three research questions:

1. How do Latinas develop and sustain their science identities during their college experience?
2. How do they make meaning of their formal and informal STEM experiences?
3. What are the relationships between science identity and other identities (e.g., gender identity, racial identity, socio-economic status identity)?

Carlone and Johnson's (2007) model of science identity explored how women of color constructed meaning from their science experiences and how larger society influenced meanings attached to science experiences. The grounded model of science identity includes three overlapping key areas: science performance (performances of scientific practices, e.g., use of technical terms, tools), science competence (understanding of content), and science identity recognition (self- and outside recognition as a "science person"). This model was informed by Gee's theory of identity (1999, 2000) which puts forth the belief that "identity is, in part, informed by the 'kind of person' one is seeking to be and enact in the here and now" (Gee, 1999, p.13). In addition to the model of science identity (Carlone & Johnson, 2007), this research study also took an intersectional approach (Crenshaw, 1991) to capture the science identity development

of Latinas in STEM in relation to elements of their gender, race, and other identities as well as to strengthen the overall framework for the research study. This approach revealed the multidimensional nature of science identity development and the influence of multiple identities upon the development process.

This research study utilized a phenomenological approach to examine the lived experiences of 16 undergraduate Latinas majoring in the STEM disciplines at a tier-one predominantly white public research university in the southwest. Participants met the following criteria: (a) be over the age of 18, (b) identify as Latina or Hispanic, (c) identify as female, (d) be classified as a college junior or senior, and (e) be currently enrolled as a science, technology, engineering, or math major. The study centered upon the perspectives of Latina juniors and seniors in STEM because their persistence through the college experience will yield an enhanced understanding of the science identity development process across multiple years within the STEM discipline and at the research site. The primary methods for data collection were: (1) pre-interview questionnaire, (2) phenomenological semi-structured interview, and (3) focus groups.

This study utilized a pre-interview questionnaire, which was administered to Latina student participants prior to the beginning of the study in order to gather demographic and background information. In addition, the pre-interview questionnaire also had items addressing STEM experiences at the institution, Science identity development, as well as identifying influential people within their experiences and degree aspirations. Data received enabled me to create greater understanding of the student

participant profile for the group as well as be able to tease out any aspects of a student's experience that might need to be explored in more depth during the interview process.

Using Seidman's (2006) model for conducting phenomenological, individual in-depth interviews, this study included the perspectives of 16 Latina undergraduate STEM majors. Each participant participated in two one-hour, semi-structured interviews. Individual interviews allowed me to delve more deeply into the participant's experience and clarify issues that are unclear to me (Ritchie & Lewis, 2009).

The purpose of interview one was to both simultaneously examine Latina experiences in STEM and build rapport. Interview one questions examined a range of topics, including: Latina interest in the STEM disciplines, Latina experiences within the STEM disciplines, and finally, provide recommendations for Latina Science identity development to students and university administrators. The purpose of interview two was to follow-up on questions from the previous interview as well as utilize an artifact discussion to delve deeper into the science identity development of Latinas in STEM. The second interview included an artifact discussion in which Latina STEM students are asked to provide five "artifacts" that demonstrate aspects of their identity. Asking participants to produce artifacts enabled me the opportunity to "read" those artifacts and discover the meanings attached to such objects by the participant (Glesne, 2011). Additional questions on the semi-structured interview protocol were targeted questions draw from prior research related to emerging Latina STEM experiences and science identity development.

Throughout the interview process, students were encouraged to expand the conversation and address any other information that they feel might be relevant to their experience. Interviews were conducted face-to-face at a mutually agreed upon location. Interviews lasted approximately one hour and were digitally recorded and transcribed verbatim for analysis.

The study also included two focus groups of Latina undergraduate STEM majors who participated in the study. Focus group one took place after interview one; focus group two took place after interview two. The phenomenological study employed the focus group approach in order to explore the Latina STEM experience and science identity development in greater depth and maximize efficient use of time, as this approach allows access to the perspectives of a number of Latinas in STEM at the same time (Glesne, 2011). Each focus group lasted around an hour and a half and was digitally recorded and transcribed for later review. Both focus groups had a brief semi-structured protocol with questions relating to the development of science identity of Latinas at a tier-one predominantly white public research university.

The purpose of focus group one was to: (a) examine STEM classroom and informal academic experiences throughout their college career, (b) explore participant perspectives on STEM achievements and challenges, (c) examine science identity development and explore intersectional identity influences. The purpose of focus group two was to: (a) explore sustained student participant interest in STEM, (b) discover meanings Latina STEM students attach to STEM achievement and science identity recognition, (c) examine future STEM plans and aspirations, and (d) gather suggestions

on how higher education administrators, faculty, and staff can better serve the identity development of Latinas in STEM through classroom-based strategies and institutional services and policies.

To make the data more accessible, each interview transcript was read several times and electronically coded for specific topics that appeared. These coding topics were determined by significant ideas and illuminative quotations that appeared within the data collected. Data was categorized under specific topic codes as I analyzed the data. The study utilized Atlas.ti, a qualitative computer data analysis software, to aid in organizing and analyzing the data. This software helped me to categorize data by code and run subsequent data reports. From this coding, initial themes emerged within each student's experience and were then compared across the remainder of the findings. During this stage, significant patterns within the data were noted and possible explanations and propositions for the findings were proposed. The study identified significant patterns that existed among the group of participants and conclusions were made based on the frequency of participant responses. I considered possible biases and differences in interpretation while organizing data and evaluating possible themes.

Discussion of Findings

This section provides a discussion of the findings of the study and situates these findings within the context of previous literature. The purpose of this study was to examine the science identity development process of Latinas in STEM and explore how intersectional identities influence development. Overall, findings suggest that Latinas in STEM utilize competence, science identity recognition, and the performance of science

identity to develop their identities. Gender, racial, career, and religious identities influenced the way in which these students made sense of their STEM experiences and processed their science identity development during college. Figure 8 (below), provides a graphic representation of the study's findings.

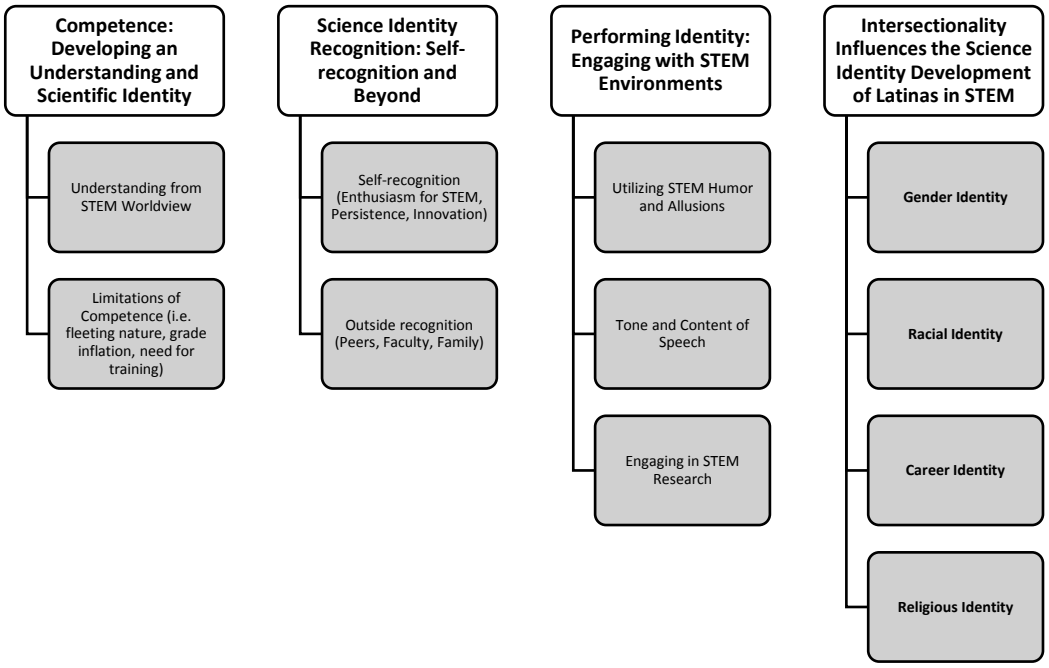

Figure 8: Overview of Findings

The discussion of this section is structured around two key findings resulting from the data: (1) Latinas made meaning and developed science identities through recognition, competence building, and, to a lesser degree performance and (2) Latinas developed science identities primarily as a result of relationships between science identity, gender, and race. This section is followed by implications for future research and

recommendations for practices and policies to improve the science identity development process for Latinas in STEM disciplines.

Key Finding #1: Latinas Made Meaning and Developed Science Identities through Recognition, Competence Building, and, to a Lesser Degree Performance (Research questions 1 and 2)

As a response to research questions one and two in regards to STEM identity development and meaning making, the findings suggest Latinas in STEM negotiate their science identities through their science competence, recognition, and performance. In terms of performance and competence, participants often connected STEM experiences to their desire for scientific learning and exploration as well as their ability to thrive within a rigorous, complex science curriculum. In terms of science identity recognition, Latinas also made sense of their STEM experiences based on how their Latina identity was negotiated by this experience while some Latinas within the study viewed their experiences through other identity lenses. Finally, most Latinas within the study attached various meanings to their STEM experiences, both inside and outside of the classroom, based on their career identities, aligning future goals and the ability to give back to their families and communities as key markers for understanding their science identity development.

This study reinforces the belief that the STEM fields are a community of practice into which aspiring STEM students must be enculturated (Christidou, 2011; Lave, 1992). Within this study one can understand how these aspiring STEM students associate or become alienated from the community and its norms and culture through an understand

of who is recognized by that community. Similar to Carlone and Johnson's (2007) findings, science identity recognition played an important role in the science identity development of the study's Latinas. For the students in this study, self-recognition was the result of a deep understanding and alignment with the learning of STEM concepts as well as an ability to understand one's place within the STEM community now and in the future. Self-recognition was also reinforced by the student's ability to persist within a STEM discipline despite the academic challenges present. Recognition from professors, family, and peers (both STEM and non-STEM) was key to students feeling like a "science person." Also, joining STEM related student groups, particularly those geared towards understanding the experiences of women or underrepresented groups in STEM helped participants to find similarly minded individuals and those who were dealing with similar struggles. Self-identifying as a "science person," a "scientist" or more generally as a scientific "explorer" reflected the ability of participants to feel a connection to the scientific inquiry mindset and the STEM community. The findings illuminated the nature of self- and out-side recognition as integral to the science identity development.

Together, recognition of these elements, which were described by students as necessary for one's success in STEM, pointed towards their recognition of themselves as STEM individuals. Because they possessed these elements, they recognized themselves as STEM individuals. Outside recognition for the students of this study came primarily from STEM peers, faculty members, and, to a lesser degree, family members of STEM students. Peer recognition enabled students to feel intellectually accepted those around them and feel as though they had met the academic standards for their STEM

environment. For the students in this study, peers recognized the participants' abilities within the discipline and future career in the field. However, gaining recognition from peers also appeared to be challenging for many students, particularly those in engineering and computer science fields. Such challenges often left students doubting their abilities and questioning their place within the STEM community.

Recognition from faculty members emerged as less important than peer recognition but still important for the science identity development of these students. The students within this study felt most validated by faculty members who were invested in their endeavors and supportive of their futures within STEM fields. Faculty members, through their recognition, had the ability to give validation to years of academic and professional work as well as act as supporters for navigating the challenging STEM curriculum and pathway to the field.

Finally, family recognition served as a supplement to other types of recognition from STEM community members. Recognition from family members was particularly important should recognition from the on-campus STEM community not recognize the student. Outside recognition was particularly important as it represented a means by which their peers and faculty members invited them into or pushed them away from the STEM community. For biology and engineering majors, peer recognition appeared to be more important whereas for engineering majors, both peer and faculty recognition appeared influential to the development process. Family recognition often played an important role for the more non-traditional STEM majors within the study, possibly due to their status within the STEM community.

Carlone and Johnson (2007) highlighted science identity recognition as the most substantial area for science identity development for women of color. Their study suggested that science identity recognition was a function of self- and outside recognition of knowledge and skills. Those findings are reinforced within the current study, as the Latinas in this study placed a high level of importance upon the recognition of the STEM peers and faculty members. Similar to the students within the Carlone and Johnson (2007) study, the students within the current study found themselves simultaneously succeeding and failing in their attempt to derive validation from their STEM communities. Students within this study at times found their knowledge, skills, and experiences to be validated by their peers and faculty (i.e. during research presentations, acknowledgements from peers) and at other times were victims of a gendered set of norms nested within a sexist environment (i.e. "spoon" feeding of information, lower expectations for women). To a lesser extent than Carlone and Johnson's study (2007), some of the women in this study attempted to refine who they felt were meaningful others in their lives. Although a few students highlighted family as a possible source of validation and recognition, students in this study expressed the continued need to be recognized by their STEM community. This may be the result of the rigorous research environment of the university or the competitive nature of STEM students within highly ranked STEM programs within the university.

The findings also revealed that all students within the study made meaning of their level of understanding regarding STEM concepts and the type of understanding gained (i.e. professional, academic). Students were acutely aware of their competence

levels and quick to discern whether grades reflected actual competence gained. Attaching meaning to that competence allowed students to increase their confidence in their academic self-concept and perpetuate their engagement with and success in their STEM discipline. Competence as a source of identity development seemed to be complicated for these students because competence was a fleeting source of validation. At one moment, they could feel competent in their abilities and in the next that competence could be in question. Students also described the pressure on them to quickly understand, apply, and innovate within STEM as an obstacle to feeling competent in their work.

Prior research suggested that Latina/o students were less likely to receive accessible, high-quality instruction and equitable funding, further discouraging interest and the ability to succeed in STEM fields (Chacon, 2000; Triana & Rodriguez, 1993; Young, 2005). Because the Latinas in STEM within this study experienced similar challenges prior to college enrollment which hindered their ability to fully engage with STEM, in some cases their science identity development only blossomed when starting college. Unlike their peers, the participants in this study may have been at a disadvantage in developing their science identities as a result of their pre-college experiences.

Carlone and Johnson's (2007) science identity development model included competence as a necessary element for development but insisted that it was not a predictor for the science identity that one developed. This study generally reinforced this perspective, especially as it highlighted the limitations for utilizing competence in the development of science identity. However, dismissing competence as necessary but not a predictor for science identity development underestimates the nature of competence and

academic self-concept. In this study, the Latinas who believed that they were competent, particularly in the computer science and engineering disciplines, were able to more easily recognize themselves as STEM individuals and have the confidence in their abilities necessary to withstand the unwelcoming environment constructed by their often directly sexist male peers.

Findings for this study support the concept of science identity performance. Students within this study utilized ways of speaking and engaging with their STEM environment that demonstrated to others that they were STEM individuals. Although present for all majors, science identity performance seemed particularly important for computer science and engineering majors. Infusing STEM humor and allusions as well as their use of authoritative tone and content demonstrated their competence to others. Performance of STEM activities, which ranged from completing undergraduate research to leading student organizations, enculturated students into the STEM community and its norms. These performances created and demonstrated knowledge to the community that, in turn, allowed others to recognize students as part of the STEM community.

Latinas within this study "performed" science by using scientific technical terms (particularly those students close to graduation) and integrating science and a feeling of exploration into their daily lives. In addition, Latinas within this study also performed science identities through their engagement with scientific contexts, such as internships with faculty or industry companies, and their produced deliverables, such as lab notebooks or programming.

Latinas in STEM displayed science competence through their engagement in undergraduate research programs (particularly those that involved them in research during their first year) and their navigation of the STEM experience and the building of necessary technical skills. Being involved in a very practical way with the research of faculty members allowed participants to understand the STEM culture and gain necessary technical skills. Participants with more varied STEM experiences and those participants approaching graduation or who possessed a job offer also tended to feel as though they were more competent in their field of study. Findings also suggest while all participants engaged developed their science identities as a result of the three main areas, the participants of this study particularly in the engineering and computer science disciplines, may have attributed more of their identity development to the areas of recognition and performance.

For Carlone and Johnson's (2007) model, performance was deemed necessary but, again, not a predictor for science identity development. However, the students in this study reinforced not only the need for performance of STEM behaviors and activities but connected those experiences to their science identities. Rather than addressing performance as a non-predictor, this model should reflect how performance of STEM behaviors and activities informs science identity recognition. With more frequent performances of science identity, self- and outside recognition grows as the participant comes to know herself as a STEM individual and proves to others that she is one as well. Additional examination of performance as it relates to race and gender merits discussion

as women of color may feel a greater need to perform within the norms of the department rather than defining those norms for themselves.

Key Finding #2: Latinas Developed Science Identities Primarily as a Result of Relationships Between Science Identity, Gender, and Race (Research question 3)

In order to address research question three, this research study utilized various elements of the theoretical frame and intersectional approach to explore the intersectional nature of science identity development. Students who recognized themselves as competent often connected that competence to outside recognition. Recognition from the outside was often connected to more social performances of STEM or recognition of one's competence within a STEM discipline. Each of the components of this framework worked together to inform science identity development within this study. However, the intersectional nature of identity developed required further analysis of these findings to determine how other identities influenced the science identity development of the Latinas within this study.

First, the Latinas in STEM within this study identified the relationship between their gender identity and science identity to be the most salient to their experience. Participants noted their gender identity as being problematic to negotiating future priorities regarding scientific endeavors and family-planning. Participants also noted the relationship between their Latina identity and science identity. Some participants discussed this relationship in reference to "being the only one" as a Latina in STEM in most instances – and, although other students denied that their Latina identity had any bearing on their science identity, the experiences that they shared in both formal and

informal contexts as well as discussions around their identity artifacts, seemed to demonstrate a relationship between the two identities which was not acknowledged.

This study is unique in its ability to fill a significant gap within the literature which has, until recently, failed to consider the dynamic relationship between racial, ethnic, and gender identities as related to the science identity development of Latinas. It simultaneously adds to the empirical evidence that scholars have advanced on Latina/os and women of color in higher education as well as contributes to the knowledge base on Latina identity development and Latina science identity development. By utilizing Carlone & Johnson's (2007) model of science identity as a primary theoretical framework and intersectionality as a secondary theoretical framework, this study illuminates how undergraduate Latinas in STEM majors make meaning of their experiences and develop their science identities over time, thus filling multiple gaps in the literature.

This research study utilized various elements of the theoretical frame and intersectional approach to explore the intersectional nature of science identity development. First, the Latinas within this study identified the relationship between their gender, racial/ethnic and career identities and science identity to be the most salient to their experience. As women in STEM, half of the participants in the study recognized that they represented a very small percentage of STEM majors. The exception came with those students in biology, human development, and public health who acknowledged a more equal representation with their male counterparts. However, despite the more equal representation in some majors, most participants still felt as though as a woman they had

been talked over, had their ideas not attributed to them, and had their competence challenged.

Participants also noted the relationship between their Latina identity and science identity development. Although other students denied that their Latina identity had any bearing on their science identity, the experiences that they shared seemed to demonstrate a relationship between the two identities, which was not acknowledged. Some participants discussed this relationship in reference to "being the only one" as a Latina in STEM in most instances. Students recognized that their identity as a Latina and their place within the STEM field was problematic for some people who do not equate Latina with scientist, engineer, mathematician, etc. For these students their identity as a woman is compounded by their identity as a Latina, causing difficulty for them to "see" themselves as successful, especially when there are few role models who share their gender and background.

Finally, this study extends the science identity using an intersectional theoretical framework in order to gain a more nuanced vision of the STEM experiences and science identity development of Latinas in college. Contrasting the engineering and computer science students' need for recognition and performance for science identity development, more socially conscious STEM majors, such as public health and human development, had science identity development patterns that intersected with their career identities. Participants in these majors connected their science identity development to future career plans primarily dealing with improving the world around them and problem-solving. Some of these students became acutely aware of their career identities intersecting with

their science identity development because their career choice was often beyond the traditional STEM context (i.e. interdisciplinary, non-industry, non-profit).

Previous research has examined the relationship between altruism for girls and women of color (Brickhouse et al., 2000; Jonson, 2006; Seymour & Hewitt). Most of the participants within the study related how their career identity influenced their science identity development and their desire to work within their communities using their STEM degree. Connecting aspects of altruism and career identity to the science identity development of Latinas could encourage more of these students to enter STEM fields as a means of helping their communities and making a broader impact. This study's findings were similar to Carlone and Johnson's (2007) findings in the fact that both studies highlighted the importance of altruism to the science identity development process, but the current study classifies altruism as part of an intersecting career identity rather than simply part of one's definition of self-recognition. For the current study, the influence that career identity had not only on how a student chose to recognize herself but the associated effects that this identity had on the subsequent educational decisions, pathways, and long-term goals merited a greater role in the science identity development process. Career identity not only affected how a participant recognized herself but also influenced the way in which others saw her as well as the way in which she performed her science identity, all of which was mediated through the lens of race and gender identities, too.

Implications for Research, Practice, and Policy

While substantial research has been conducted on women in STEM and on students of color in STEM, the experiences of women of color in STEM have been neglected in the research agenda until recently (e.g. Cantu, 2012; Espinosa, 2011; Ong, et al., 2011). However, most of these studies focus broadly on women of color rather than provide a thorough understanding of the lived experiences of African American, Asian America/Pacific Islander, Chicana/Latina, and Native American female subgroups. Specifically, prior research has grouped Latinas in terms of their race/ethnicity (Latina/os), their gender (women), or the intersection of their race/ethnicity and gender more broadly (women of color), but has not formally extrapolated information pertaining to the unique individual experiences of the subgroup of Latinas in STEM which help to paint a rich portrait of their collective experiences.

Future Research. The purpose of the study was to gain an in-depth understanding of how successful Latina college students develop and make meaning of their science identities. As a result, this study illuminated meaningful information about how Latinas in STEM disciplines made meaning of their STEM experiences both in and outside of the classroom. Although this study served as an important step towards understanding science identity development for Latinas in STEM disciplines, further research in this area is needed in order to more fully understand the science identity development process. In particular, future research should continue to address the intersectional nature of science identity development while also further examining institutional context and disaggregating by discipline area. Furthermore, the investigation

of science identity development would be enhanced by examining this development through the progression of academic STEM degrees as well as by utilizing additional theoretical frameworks to understand the relationships between STEM experiences and identity development.

This study highlighted the multidimensional nature of science identity development for Latinas and the need for further discussion of intersectionality Therefore, further research which addresses the intersectional nature of science identity development for Latinas in STEM disciplines must be conducted in order to capture a more nuanced view of their science identity development. Although this study primarily dealt with how gender and racial identities intersected with science identity, future research should address the influence of class on science identity development as well as explore the influence of career and religious identities in greater depth. Exploration of these areas could provide greater insight into the nature of science identity development for Latinas from varying socioeconomic backgrounds as well as understand the ways in which other identities influence the identity development process. This investigation would fill a needed gap in the literature as well as provide a basis for understanding how researchers, administrators, and policy makers can best enhance the STEM educational pipeline for this population while remaining sensitive to the multidimensional nature of science identity development.

As a result of this study, it is also evident that further research is needed to gain an understanding of how STEM institutional context affects science identity development for Latinas in STEM fields. Future research should examine science identity development

for Latinas at Hispanic serving institutions (HSIs) and in the context of community colleges. Latinas at HSIs may develop their science identities in markedly different ways than their peers at predominantly White institutions (PWIs), particularly in regards to the influence of racial identity on science identity development. Furthermore, Latinas at community colleges may experience their science identity development in distinct ways as a result of part-time status, low socioeconomic backgrounds, or differing college STEM experiences. Each of these contexts may reveal additional nuance to understanding science identity development and exploring the theoretical frameworks used within this study.

Also necessary is the examination of individual discipline areas within STEM (e.g. science, technology, engineering) to further understand the dynamics that exist within these contexts and determine what unique features may exist in each area. Although this study does a preliminary examination of Latinas in STEM broadly, the study is limited in its ability to delve into the application of the theoretical framework to specific disciplines. Further research should disaggregate identity development by discipline in order to understand how each of these disciplines within STEM is unique, and depending, on the type of science, experiences may be starkly different. Future research should focus particularly on the disaggregation of the engineering technologies, mathematics and statistics, computer and information sciences, physical sciences, and engineering disciplines in which Latinas are most under underrepresented (*Excelencia* in Education, 2015).

Future research should also examine science identity development as a progression through STEM degrees, especially beyond the bachelor's level. Looking at development across time and degree attainment could yield nuanced views of how science identity development evolves over time and which elements of development are most salient at differing levels of attainment or critical junctures in the STEM pipeline. Information related to how science identity development differs at the associates, bachelor's, master's, and doctoral levels may allow STEM experiences to be tailored in greater detail to the identity development needs of Latinas at various levels, rather than seeking a general approach to enhancing science identity development for Latinas in STEM.

Finally, applying differing frameworks to the science identity development process could also illuminate greater nuance to the study of Latinas in STEM. Although Carlone and Johnson's (2007) science identity development framework integrates elements of race, gender, and class and an intersectional approach addresses the multidimensional nature of identity development, this study could benefit from exploring these issues from a Chicana Feminist Theory standpoint (Anzaldúa, 1987; Garcia, 1989). Chicana feminist theory expands the discussion of race as a critical variable to analysis by connecting the discussion of race with the discussion of gender in the experiences of Chicanas. As a result, the Chicana feminist perspective would provide an opportunity for Mexican American women to be understood given their racialized, classed, and gendered identities. Given the growing number of Mexican American women entering higher

education and STEM disciplines, this framework will be useful in future research to investigate the science identity development process from a more critical standpoint.

Practice and Policy. This study will assist educational stakeholders in understanding the multidimensional nature of science identity development for Latinas in STEM disciplines as well as provide a basis for informed decision making regarding STEM practices and policies. As a result of this study, educational stakeholders will be able to enhance science identity development and, ultimately, improve undergraduate persistence and graduate school and/or workforce outcomes for Latinas in STEM disciplines by considering the way in which these Latinas constructed their science identities. This study provided insights for understanding the current STEM educational practices and policies which encouraged science identity development and expanded the discussion to include an examination of how these current practices and policies might be enhanced to incorporate an intersectional approach to science identity development.

To encourage the development of competence among Latinas in STEM, educational stakeholders should institutionalize the scientific inquiry process as well as integrate discussions spaces that explore the science identity development process. Institutions should seek to define and institutionalize the scientific inquiry processing into each level of coursework, emphasizing critical thinking as integral at each level. Faculty members should also encourage the building of STEM competencies through scaffolding engagement activities, which encourage STEM experiential learning, and scientific inquiry leading to increased knowledge and skill-building. The creation of a learning frameworks course for STEM fields in which students immerse themselves in the

scientific inquiry process and develop a line of inquiry may encourage students at an early stage to construct a STEM worldview. In addition, stakeholders should integrate discussions of the traditional ways of thinking and speaking that students and society believe to make a STEM person and present challenges within those spaces to those traditional ideas of what it means to think and speak like a STEM person. Challenging university spaces to include more women of color in defining those aspects as well as integrating perspectives aligned with intersectionality, will create a space which is inviting to women of color and perpetuates the ability to express themselves, ask questions, and establish their own norms for thinking and speaking.

To encourage self- and outside recognition of knowledge and skills, Latinas in STEM should be given the opportunity to engage in activities which integrate them into the STEM community as well as assist them in redefining who they consider to be meaningful in the science identity recognition process. These students will benefit from STEM curricular and extra-curricular engagement that is early, often, and meaningful. Faculty members should train students as if they were apprentice scientists, shifting the model from rote knowledge to a more experiential- based model where students are presented the ability to be recognized by peers and faculty in the STEM community. Institutions might also consider requiring STEM students to engage in internship experiences so that students can "see" themselves in a given field and build a sense of self-recognition of science identity. Similarly, institutions might also consider creating spaces for creation and innovation by encouraging engagement with application-based events such as hack-a-thons that enable students to showcase new ideas, build

competence and skills, and gain outside recognition from the STEM community. Engaging in these events could be connected with STEM curriculum, co-sponsored with STEM-focused student organizations, or partnered with company sponsors as a recruiting tool. Institutions may encourage faculty members to work closely with undergraduate students on initiatives such as these by providing incentives for this type of work (i.e. course remission, greater lab space) or attaching participation in these events to institutional funding sources. Higher education stakeholders should also support the efforts of Latina/o-centered or women-centered STEM organizations to connect Latinas to professionals in their field who are similar to them. Creating or enhancing existing partnerships between these Latina/o- or women-centered STEM organizations and other entities, such as the Hispanic Alumni Association, could connect undergraduate Latinas in STEM with professionals in their field. These connections could provide pathways for understanding the profession in greater detail as well as gaining professional contacts needed for the career search. In contrast, in terms of outside recognition, educational stakeholders may also encourage Latinas in STEM disciplines to redefine who they consider meaningful others to include more family and non-STEM peers. Curriculum should emphasize the applicability of STEM concepts to everyday life and how they can share their knowledge with others. Despite the fact that STEM peer and faculty recognition was of great importance to the Latinas in this study, some students may seek to define their outside recognition along familial and non-STEM lines, rather than by merely the STEM community. In order to facilitate this outside recognition and create a more inviting environment for Latinas in STEM, the university should invite parents and

family to STEM achievement marker events (i.e. research presentations, awards ceremonies) so that they feel a part of the STEM environment and can see their daughter's achievement within the STEM community.

Participants within this study also highlighted the need to perform their STEM identities in a variety of ways and environments. Providing students the opportunities to perform, as STEM individuals will enable students to further develop their science identities. Faculty members can do this by connecting STEM subjects to everyday life through classroom content and interactions, highlighting relevant topics in the news or events on and off campus related to these areas. As their STEM discipline becomes part of their life, students will have the ability to integrate and share their knowledge on a more regular basis with STEM and non-STEM peers. Faculty members and other instructors can also encourage performance by giving Latinas, and other women of color, the opportunity to speak in classes and discussion sections in order to build an authoritative tone and space for performing competence. Latina/o- or women-centered student organizations also present an opportunity for students to perform in front of peers, perhaps through talking about their previous research experiences, class projects, or internships. Finally, institutions may want to consider requiring a research, application-based, or problem-based learning requirement for students in STEM disciplines. Such a requirement will allow students who have not had these experiences elsewhere to place themselves in an active role in their learning and connect those experiences to the development of their science identity. If these types of experiences are difficult to implement, institutions may also look at redefining how one becomes involved with

STEM and looking towards ways to integrate these experiences with other fields to create multidisciplinary research tracks or experiences. Institutions should utilize these types of opportunities to connect learning outcomes to career goals and altruistic desires as well as demonstrate the marketability of such plans of study.

At the institutional policy level, there is a need to evaluate and develop partnerships and strategies to improve STEM teaching, learning, and professional experiences. This requires administrators to gain an understanding of the institutional landscape of STEM curricula and programs in order to avoid duplication, identify gaps, and propose new partnerships and strategies to address the challenges and opportunities in promoting student success and science identity development for Latina STEM students. Administrators must establish the needs and significance of addressing science identity development for these, and other, underrepresented students in the STEM pipeline as well as identify partners and collaborators for enhancing outcomes in these areas. These collaborations should leverage expertise and resources in order to make a collective impact on the science identity development experiences of students by coordinating multiple programs and services that will have a greater effect that a single strategy alone. Institutions should identify federal, foundation, and industry funding to support these partnerships that advance STEM education and provide opportunities for science identity development during the college experience.

This study demonstrates the need for applying an intersectional approach the improvement of STEM experiences and development of science identities. Administrators should create spaces for discussion of how multiple identities affect

STEM experiences and how the institution could improve their programs and services to be inclusive of these multidimensional experiences. These discussions could be integrated into existing student success courses at the college level or STEM Freshman Interest Groups (FIGs) in order to encourage science identity development and exploration of how to navigate multiple intersecting identities. Faculty, staff, teaching assistants, and peer leaders should be trained on the nature of intersectional identities and how these experiences influence science identity development. The institution should also create opportunities for students to express multiple identities through curricular or extra-curricular experiences (coursework, internships, research) and student participation in Latina/o- or women- centered STEM organizations.

This study presented several practical implications for the manner in which institutions consider intersectional identities in relationship to science identity development, including the role that gender, race, career, and religious identities play in that development. Institutional consideration of gender to the science identity development process can include strategies related to the hiring and training of faculty, staff, and students as well as the creation of spaces that enable women to be successful within the STEM environment. Institutions can demonstrate a commitment to addressing gender issues by hiring more women STEM faculty and staff and engaging in a frank discussion about the challenges facing women entering these areas. Institutions should also train all faculty and staff members to be cognizant of the role that gender plays in formal and informal STEM experiences as well as address issues related to women's imposter syndrome and society's underlying assumptions that women are not capable of

STEM success. These conversations should also include discussion regarding the intersectional nature of being a woman of color in a traditionally White male space and how those related experiences complicate science identity development.

Institutional consideration of the role that race plays in science identity development, especially for women of color, can be shown through the institution's commitment to encouraging integration into the STEM community while simultaneously rewriting the narrative surrounding participation for women of color in these fields. Latina/o-centered STEM organizations have the capacity to encourage Latina participation in the STEM community, but these organization should be challenged to consider how gender and other intersectional identities may affect student participation. Exploring the way in which Latinas participate within this organizations could illuminate ways in which these student organizations could integrate intersectional approaches to the work that they do in the development process. Institutions have the ability to rewrite the current narrative regarding Latinas in STEM in their consideration of marketing materials and presentation of science history as well as their attempt to make the STEM community experience more inclusive and culturally relevant. Institutions should seek ways in which they can highlight the successes of Latinas in STEM and provide opportunities for these students to have visibility among their STEM faculty and peers.

Finally, this study provides recommendations for practices that explore the intersectional nature of career and religious identities with science identity development. In order to explore the influence that career identity has on the science identity development of Latina students, institutions should move towards integrating career

planning into curricular activities and encouraging interdisciplinary or non-traditional STEM plans for the future. For Latinas in STEM, institutions should assist students with the alignment of their career goals with broader social impact. Institutions should move towards creating more problem-based learning activities to incite interests, particularly around the healthcare fields, and demonstrating that there are multiple outlets for utilizing STEM degrees for broader impact. Potential partnerships may be possible between departments to host events related to the STEM needs of the Latina/o community. To a lesser degree, students within this study related information related to how their religious identity affected their science identity development. Although further research in this area is needed, institutions may consider creating a space for discussing the issues inherent with spirituality and participation in a STEM discipline. Partnering with faith-based organizations for these discussions could yield greater insight into how these identities inform each other.

Appendix A: Email to Recruit Student Participants

Dear (Student's Name),

I hope that you are having a great start to your semester! My name is Sarah Rodriguez, and I am a doctoral student at The University of Texas at Austin. I am currently working on my dissertation focused on exploring the science identity development of undergraduate Latina students in the science, technology, engineering, and math (STEM) fields here at the university.

I received your contact information from (insert contact's name). S/He indicated that you might be a good candidate for my study and that you might be interested in participating. Deciding to participate in my study is completely voluntary, and you may elect to discontinue your involvement at any time, without any negative consequences.

If you agree to participate in my study, I will interview you individually on two separate occasions and invite you to two mandatory group interviews (focus groups) with other undergraduate Latinas in the (STEM) disciplines. I will also send you all the interview questions ahead of time so you can review them and prepare, if necessary.

In order to participate in my study, you must answer "yes" to the following questions:

- Are you over 18?
- Do you identify as Latina/Hispanic?
- Do you identify as a female?
- Are you classified as a college junior or senior?
- Are you currently enrolled as a science, technology, engineering, or math major (must be in the College of Natural Sciences, College of Engineering, or College of Nursing)?

If you meet the above requirements and are interested in participating in my study, please reply with your responses to these questions to confirm your eligibility. Also, please indicate your anticipated work/class schedule so I can work with you to coordinate the interviews and focus groups necessary for this study. Please let me know if you have any questions. I am available via email, rodriguezsarah727@gmail.com, or by phone, 903-288-1682.

I look forward to hearing from you!

Thanks,

Sarah Rodriguez
Doctoral Student, Higher Education Administration
The University of Texas at Austin

Appendix B: Email for Student Participant Selection

Dear (Student's Name),

Thank you for your interest in participating in my study! I am writing to notify that you have been selected as a participant. As a reminder, the purpose of my study is to explore the science identity development of undergraduate Latina students in the science, technology, engineering, and math disciplines here at the university. Based on the schedule you submitted, I would like to schedule a one-on-one interview with you on (day, date, time, place) or (day, date, time, place). Please let me know which you would prefer.

Also, there are three attachments for you to review prior to our first meeting.

- The first attachment is the consent form for this study. Please fill out the relevant information and sign your name.
- The second attachment is the pre-interview questionnaire. This short form asks for your background information. All of your responses to the questionnaire will be kept anonymous.
- The third attachment is the list of interview questions I am going to ask you when we meet.

Please let me know if you have any questions or concerns regarding my study or the attached documents. Thank you again for your willingness to share your perspective, and I look forward to hearing from you soon so we can coordinate our first interview.

Thanks,

Sarah Rodriguez
Doctoral Student, Higher Education Administration
The University of Texas at Austin

Appendix C: Pre-Interview Questionnaire

All responses will be kept confidential, and your identity will remain private. Your responses to these questions are optional, but will be extremely helpful to the research. Thank you!

Please print all of your responses.

Name: _____ Age: ____ Sex: _____ HS GPA: _____

Major: _____ Minor: _____

Phone/Cell #: _____ Email: _____

Preferred communication (check all that apply): ___Phone Call ___Text ___Email ___Other
If you selected "Other," please explain:
_____

Pseudonym/Codename: _____
Language(s) you speak:
_____

Language(s) you prefer to speak at home: _____ at school: _____

Mother's highest level of education?
_____

Father's highest level of education?
_____

Country where parents were born: mother _____ father_____

Please check or circle.

Family Yearly Income (select one):

Under $19,999	$60,000-$69,999
$20,000-$29,999	$70,000-$79,999
$30,000-$39,999	$80,000-$89,999
$40,000-$49,999	$90,000-$99,000
$50,000-$59,999	$100,000+

Were you the first in your family to go to college? ___ Yes ___ No
Were you in the top 10% of your high school class? ___ Yes ___ No

Are you involved in any STEM (science, technology, engineering, and/or mathematics) women's organizations (i.e. Women in Chemistry, Women in Computer Science, Society of Women Engineers)? If so, which one(s)
_____

Are you involved in any other organizations (i.e. sororities, Society of Hispanic Professional Engineers, Latino Leadership Council)? If so, which one(s)_____

I am satisfied with my overall educational experience.

1 2 3 4 5

Extremely Satisfied Extremely Dissatisfied

I am satisfied with my overall STEM (science, technology, engineering, and/or mathematics) educational experience.

1 2 3 4 5

Extremely Satisfied Extremely Dissatisfied

I feel competent in the major that I have chosen.

1 2 3 4 5

Strongly Agree Strongly Disagree

I engage in STEM activities on a regular basis.

1 2 3 4 5

Strongly Agree Strongly Disagree

I consider myself a science, technology, engineering, or mathematics "person".

1 2 3 4 5

Strongly Agree Strongly Disagree

Others recognize me a science, technology, engineering, or mathematics "person".

1 2 3 4 5

Strongly Agree Strongly Disagree

I feel a strong sense of community within my major(s).

1 2 3 4 5

Strongly Agree Strongly Disagree

I have positive interactions with the faculty members within my major(s)?

1 2 3 4 5

Strongly Agree Strongly Disagree

I have positive interactions with the other students within my major(s)?

1 2 3 4 5

Strongly Agree Strongly Disagree

Short Answers

What are two reasons that you chose your major?

Who do you consider to be the most influential person/people in your life right now?

What is the highest degree you hope to achieve? (e.g. Associates, Bachelors, Masters, etc.)

Appendix D: Interview Protocol for First Semi-Structured Interview

Person being interviewed:

_____

Date, Time:

_____

Pseudonym Chosen:

_____

Setting the Context

1. Tell me a little bit about yourself. What year are you in school? Where are you from? What's your major?
2. Tell me a about the process of applying for colleges. Where did you apply? Why did you ultimately decide on UT?
3. What was it like coming to campus for the first time?

Interest in STEM

4. Tell me about your interest in _____ (your STEM major).
    - How did you develop an interest in this field of study?
    - Who was influential in the development of your interest in this area? How so?
5. Do you think of yourself as a "science/math/tech person"? How so?
    - Do other people recognize you as a "science/math/tech person"? Why might they have thought of you in this way?
6. Have you been encouraged or discouraged to pursue a degree in _____ (your STEM major)?
    - How did your family react to your interest in this area?
    - How did your teachers or faculty members react to your interest in this area?
    - How did your peers react to your interest in this area?
7. Tell me about your short-term and long-term goals.

Latina Experience in STEM

8. How has your identity as a woman influenced the experience you have had in _____ (your STEM major)?
9. How has your identity as a Latina influenced the experience you have had in _____ (your STEM major)?
10. What are other aspects of your identity that you think are important for me to know in order to understand your experience?
11. How might things be different if you were male, a different race/ethnicity, at a different university, lived in a different place?

Beyond the individual

12. What advice about becoming a _____ (your STEM major) would you give to a high school senior who is transitioning to college? What if he or she was thinking about coming to UT? What specific advice would you give?
13. In what ways could the university better help you to be successful in your field?
14. Is there anything else you'd like to tell me that you think is important for me to know to understand about your experience as a Latina in _____ (your STEM major)?

Appendix E: Interview Protocol for Second Semi-Structured Interview

Person being interviewed:

_____

Date, Time:

_____

Pseudonym Chosen:

_____

Follow-up Questions

1. Follow-up on any questions that have been unclear or not been answered from previous interview.

Artifact Discussion

1. You were asked to bring in **five** artifacts that would demonstrate aspects of your identity.
    a. What were the artifacts?
    b. What makes these artifacts significant?
    c. How does each artifact relate to aspects of your identity?
2. If you had to discard one of these artifacts:
    a. Which would you choose to discard?
    b. How would that affect your identity?
    c. What might be different about your college experience?
3. How do the aspects of your artifacts interact with your identity as a "science/math person"?
4. How do the aspects of your artifacts interact with other parts of your identity?
5. What parts of your identity do you believe are strongest? What parts of your identity do you believe are not as strong?

STEM Competence

6. What skills, qualities, and competences have been important to your success in a STEM major?
    a. How did you acquire these skills, qualities, and competences?
    b. Why did you feel it was necessary?
7. Do you feel like your grades reflect your competence?
8. How prepared are you to make a contribution to your field of study?

Science Identity Recognition

9. What does it mean to you to be a "science/math person"?
10. Compare your identity as a "science/math person" as a college freshman to now.
11. How has your identity as a "science/math person" changed since the beginning of your college experience?
    a. What experiences validated you as a "science/math person"?

b. What experiences did not validate you as a "science/math person"?

Looking Forward

12. How might your identity as a "science/math person" affect your future career aspirations?
13. Any additional information you think I should know about your identity development as a STEM major?

Appendix F: Protocol for First Focus Group

Focus Group Participants:

_____

Date, Time:

_____

Pseudonyms:

_____

Setting the Context

1. Please introduce yourself to the group – your name, major, classification, and hometown.
2. Tell me about your culture, your background, your friends, and your family.
3. What are your favorite/least favorite aspects of your STEM classes?
4. What is the greatest achievement that you have had as a STEM major?
5. What is the greatest challenge that you deal with as a STEM major?
6. Do you feel you were prepared academically for STEM college classes?
7. What resources proved most effective in your success as a STEM major?

Science identity

8. When you think of the words "scientist," "engineer," or "mathematician," what words or images do you think of?
    a. Why do you think those images exist?
    b. How do those images compare with you?
9. What stereotypes have you encountered about women or people of color in STEM?
10. How, if at all, have your interactions with _____ shaped who you are?
    c. STEM faculty members
    d. STEM classmates
    e. STEM advisors
11. How do you think that your experience compares with that of other students?
    f. White male/female students
    g. Latino male students
    h. Other students of color
12. How do other aspects of your identity affect your identity as a STEM major?
    a. How might have these other aspects encouraged your success?
    b. How might have these other aspects inhibited your success?
13. Is there anything else you would like to share about being a STEM major?

Appendix G: Protocol for Second Focus Group

Focus Group Participants:

_____

Date, Time:

_____

Pseudonyms:

_____

_____

1. Please introduce yourself to the group – your name, major, classification, and hometown.
2. What has sustained your interest in attaining a STEM degree?
3. How do you know when you or someone else has achieved "success" in their STEM major? or their STEM career?
    a. How does this person speak/perform in front of others?
    b. What abilities or understandings of STEM does this person have?
    c. How does someone get recognized as being successful?
4. How does your identity as a Latina influence your STEM experience?
    i. Does your identity as a Latina influence the way that you view yourself as a STEM major?
    j. Does your identity as a Latina influence the way that others view you as a STEM major?
5. During your experiences at UT, how has what you have learned and the experiences that you have had inspired you to think about your future?
6. What are your plans/aspirations for the future?
    a. What achievements do you hope to have?
    b. What challenges do you anticipate?
7. What are the specific issues that universities and the public need to understand about Latinas pursuing degrees in STEM?
8. What are **two** ways that the university could help Latinas succeed in STEM majors?
9. What are **two** ways that the university could help Latinas build an identity as a "science/math person"?
10. Is there anything else that I should know about your experiences as a Latina in STEM?

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