

The Characteristics and Experiences of Successful  
Undergraduate Latina Students Who Persist in Engineering

by

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## ABSTRACT

Females and underrepresented ethnic minorities earn a small percentage of engineering and computer science bachelor's degrees awarded in the United States, earn an even smaller proportion of master's and doctoral degrees, and are underrepresented in the engineering workforce (Engineering Workforce Commission, [2006], as cited in National Science Foundation, 2012; United States Department of Education, [2006], as cited in National Science Foundation, 2009a; United States Department of Education, [2006], as cited in National Science Foundation, 2009b). Considerable research has examined the perceptions, culture, curriculum, and pedagogy in engineering that inhibits the achievement of women and underrepresented ethnic minorities. This action research study used a qualitative approach to examine the characteristics and experiences of Latina students who pursued a bachelor's degree in the Ira A. Fulton Schools of Engineering at Arizona State University (ASU) as part of the 2008 first-time full-time freshman cohort. The researcher conducted two semi-structured individual interviews with seven undergraduate Latina students who successfully persisted to their fourth (senior) year in engineering. The researcher aimed to understand what characteristics made these students successful and how their experiences affected their persistence in an engineering major. The data collected showed that the Latina participants were motivated to persist in their engineering degree program due to their parents' expectations for success and high academic achievement; their desire to overcome the discrimination, stereotyping, and naysayers that they encountered; and their aspiration to become a role model for their family and

other students interested in pursuing engineering. From the data collected, the researcher provided suggestions to implement and adapt educational activities and support systems within the Ira A. Fulton Schools of Engineering to improve the retention and graduation rates of Latinas in engineering at ASU.

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## TABLE OF CONTENTS

	Page
LIST OF TABLES.....	viii
LIST OF FIGURES.....	ix
DEFINITION OF TERMS.....	x
CHAPTER	
1 INTRODUCTION .....	1
Problem Statement .....	4
Research Question .....	6
Community of Practice .....	6
Researcher.....	9
Theoretical Lens.....	11
2 LITERATURE REVIEW .....	15
Latinos in Higher Education .....	15
Latinas in Science, Technology, Engineering, and Math ..	17
Barriers to Persistence in Engineering .....	20
Financial Need .....	20
The Role of Family .....	21
Classroom Climate.....	22
Departmental and School Climate .....	23
Self-Efficacy .....	25
Lack of Interest in Engineering.....	26
Persistence Strategies and Solutions.....	27

CHAPTER	Page
	Peer Networks and Support .....28
	Relationships with Faculty and Staff .....29
	Financial Support .....30
	Internships and Co-ops .....31
	Engineering at ASU .....32
3	METHODOLOGY .....38
	Theoretical Framework.....38
	Action Research .....42
	Participants.....45
	Data Collection and Management.....50
	Data Analysis .....56
4	FINDINGS .....62
	Familial Expectations for Success .....62
	Success Through Education.....63
	Rationale for Educational Expectations.....66
	Financial Benefits of Educational Success .....69
	When Expectations Conflict with Desires .....71
	Familial Expectations Conclusion .....75
	Overcoming Discrimination, Stereotypes, and Non-Believers .....75
	Barriers to Success .....76
	Strategies for Success .....79

CHAPTER	Page
	Discrimination, Stereotypes, and Non-Believers
	Conclusion .....83
	Influencing Others as a Role Model .....84
	Making an Impact .....85
	Influence on Younger Siblings .....86
	K-12 STEM Education .....88
	Peer Mentoring in Engineering at ASU .....91
	Role Modeling Conclusion .....92
	Conclusion .....93
5	DISCUSSION & CONCLUSION .....94
	Discussion: Parental Expectations .....94
	Discussion: Overcoming Obstacles .....97
	Discussion: Giving Back to the Community .....99
	Implications for Practice .....101
	Recruiting and Retaining Family Members .....102
	Ethic of Care in Working with Students .....103
	Eliminating the Deficit Model .....105
	Value Outreach Efforts .....107
	Recommendations for Future Research .....108
	Conclusion .....111
	References ..... 113

Appendix		Page
A	ENGINEERING PLUS ACTIVITIES.....	122
B	ARIZONA STATE UNIVERSITY INSTITUTIONAL REVIEW BOARD APPROVAL .....	126
C	RECRUITMENT SCRIPT – PHASE 1.....	128
D	INFORMATION LETTER – PHASE 1.....	130
E	RECRUITMENT SCRIPT – PHASE 2.....	132
F	INFORMATION LETTER – PHASE 2.....	134
G	INTERVIEW PROTOCOL – PHASE 1.....	136
H	INTERVIEW PROTOCOL – PHASE 2.....	139
I	RECRUITMENT SCRIPT – OBSERVATION .....	144
J	INFORMATION LETTER – OBSERVATION .....	146



LIST OF TABLES

Table		Page
1.	Engineering Bachelor’s Degrees Awarded to Females and Hispanics in the United States by Discipline, 2006.....	18
2.	One-Year Persistence Rates for Female First-time Full-time Freshmen in Engineering .....	33
3.	One-Year Persistence Rates for Hispanic First-time Full-time Freshmen in Engineering.....	33
4.	Persistence and Graduation Rates for First-time Full-time Freshmen in Engineering .....	35
5.	Participants by Major with Demographic Data .....	50

## LIST OF FIGURES

Figure	Page
1. Eccles Expectancy Value Model of Achievement-Related Choices...	13

## DEFINITION OF TERMS

### 1. American

In this study, *American* refers exclusively to the United States. It does not include other parts of North America, Central America, Latin America, or South America.

### 2. Hispanic vs. Latino

According to a 2008 survey by the Pew Hispanic Center, 36% of respondents preferred the term *Hispanic*, 21% preferred *Latino*, and the remaining 43% had no preference (Passel & Taylor, 2009). Those with a preference usually cite partiality due to their heritage—Latinos from the indigenous people of Central and South America and Hispanics with Spanish ancestry. In the 2010 census, “‘Hispanic or Latino’ refers to a person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin regardless of race” (Passel & Taylor, 2009, p. 2). Because the community has not universally accepted a common terminology, Hispanic and Latino are used interchangeably throughout this study. The researcher typically used Latino when presenting research, but mimicked the terminology used by participants in interviews and identified specific regional or ethnic populations when available.

### 3. Persistence vs. Retention

Pascarella and Terenzini (2005) refer to *persistence* as “the progressive reenrollment in college, whether continuous from one term to the next or temporarily interrupted and then resumed” (p. 374). More importantly, they

assert that persistence can be considered an appropriate condition for degree attainment (Pascarella & Terenzini, 1991). Similarly, *retention* refers to the percentage of students who return to an institution in subsequent years. Most commonly, retention data is collected for a cohort of students who enroll full-time at a postsecondary institution as incoming freshmen seeking their first bachelor's degree. Because these students begin at the same time and academic grade level, they produce more accurate retention rates than non-degree seeking students or transfer students. Retention rates are often measured each year for six continuous years. Although the terms are similar, persistence represents the result of specific student behavior, while retention is the result of institutional efforts and actions (Braxton, Hirschy, & McClendon, 2004).

#### 4. Graduation

Latina students at all levels must be encouraged to pursue math, science, and engineering. However, this study specifically focused on the undergraduate achievement of Latinas in engineering. In this study, *graduation* is used to describe the attainment of a student's first undergraduate (bachelor's) degree. Similar to retention rates, graduation rates ordinarily reflect degree attainment after four or six years of continuous enrollment (Capaldi, Lombardi, & Yellen, 2006).

#### 5. Engineering at ASU

There are currently two schools at Arizona State University that offer bachelor's degree programs in engineering—the Ira A. Fulton Schools of

Engineering and the College of Technology and Innovation. For the purposes of this study, any reference to “Engineering at ASU” will refer exclusively to the Ira A. Fulton Schools of Engineering on the Tempe campus. This distinction is important, as the two schools have different structures and administration, attract a different student body, offer courses on two separate campuses, and employ different pedagogy and curriculum. As of the Spring 2012 semester, the Ira A. Fulton Schools of Engineering offered 14 diverse undergraduate majors that lead to a Bachelor of Science (BS) or Bachelor of Science in Engineering (BSE). Engineering at ASU includes the following 14 degree programs: Aerospace Engineering (BSE), Biomedical Engineering (BSE), Chemical Engineering (BSE), Civil Engineering (BSE), Computer Science (BS), Computer Systems Engineering (BSE), Construction Engineering (BSE), Construction Management (BS), Electrical Engineering (BSE), Engineering Management (BSE), Industrial Engineering (BSE), Informatics (BS), Materials Science & Engineering (BSE), and Mechanical Engineering (BSE) (Arizona State University, 2011).

#### 6. Characteristic

This study identified characteristics of successful Latina persisters in engineering. Characteristic is defined as “[a] distinguishing trait, quality, or property” (*Merriam-Webster’s Collegiate Dictionary*, 1993, p. 192).

#### 7. Experience

This research also identified the experiences of successful Latina persisters in engineering. An experience is defined as “the fact or state of having been

affected by or gained knowledge through direct observation or participation...something personally encountered, undergone, or lived through” (Merriam-Webster’s Collegiate Dictionary, 1993, p. 409).

## CHAPTER 1

### INTRODUCTION

In the United States (U.S.), females, Latino/as, Native Americans, and African Americans are underrepresented in the science, technology, engineering, and math (STEM) fields. Females earn less than 20% of American engineering degrees and comprise only 13.5% of positions in architecture and engineering (United States Department of Education, [2006], as cited in National Science Foundation, 2009a; United States Department of Education, [2006], as cited in National Science Foundation, 2009b; U.S. Department of Labor, Bureau of Labor Statistics, 2009). Underrepresented minorities earn 16.7% of the science and engineering bachelor's degrees, and Latinos and African Americans represent only 11.8% of American employees in architecture and engineering occupations (United States Department of Education, [2006], as cited in National Science Foundation, 2009a; U.S. Department of Labor, Bureau of Labor Statistics, 2009). These statistics appear obviously disproportionate, considering that the United States Census 2010 identified 36.3% of the American population as “minority,” or “people who reported their ethnicity and race as something other than non-Hispanic White alone” (Humes, Jones, & Ramirez, 2011, p. 18). As educators and concerned members of society, we must address this inequality before it permanently damages the economy and social structure of the United States.

Traditionally, women and underrepresented minorities have been overlooked or ignored in developing the STEM workforce. This is a considerable oversight, because “[t]he attrition of women from the STEM fields represents a

loss of talent from these key disciplines, limiting their access to respected, well-paid jobs and affecting our technological competitiveness as a nation” (Battles, 2009, p. 4). One could argue that focusing on the recruitment and retention of females and ethnic minorities into the STEM fields is the right thing to do and that providing a supportive environment for diversity is “good business and all employees benefit” (Anderson-Rowland et al., 1999, p. 328). Research also shows a variety of tangible outcomes that benefit the economy and the American public, which is further reason why additional efforts should be made to equalize degree attainment in science and engineering.

The United States faces a significant shortage of engineers for the next several decades (Sinkele & Mupinga, 2011). Whether this demand is a result of the retirement of the baby boomer generation, the widespread growth of the global engineering and technology industry, or a combination of both, American society has yet to adequately access the minority workforce to meet the growing employment demand. Furthermore, Rochin and Mello (2007) assert that Latinos are among the most overlooked populations when responding to the need for a technically skilled American workforce:

In the national scene, Latinas/os are viewed as side issues when it comes to post-9/11 concerns with the slowing enrollment of college students in STEM, U.S. reliance on foreign nationals, America’s ability to compete globally, the ‘quiet crisis’ of producing skilled, professional workers, and the problems of promoting opportunities among [underrepresented minorities] for employment in STEM. (p. 344)

Therefore, Americans should more efficiently and effectively tap into the human capital that is available and underutilized. More women and minority engineers



are needed to meet the demand for a larger and more diverse engineering workforce that can address the assorted needs of customers from around the world (Anderson-Rowland et al., 1999). With the increasing demand of a global economy where fewer than half of American patents were awarded to foreign companies in 2009, the types of problems addressed by engineers will also become more complex and unfamiliar to American engineers (Kivett, 2010). Anderson-Rowland et al. (1999) argue that a diverse team of engineers supplies a variety of unique experiences and knowledge that will assist the development of a better solution than a team whose members think and act alike.

It is important, however, to note that Latino degree attainment in the STEM fields is only one piece of a larger challenge. There is a larger need to educate the American Hispanic population, which has the potential to provide extensive rewards for society as a whole. Carnevale and Fry (2000) assert that if members of the Hispanic workforce had the same level of educational achievement as their non-Hispanic White counterparts and were paid equally for that level of education, income earned by Americans would increase by \$118 billion annually and add over \$40 billion each year in tax revenue for the government. Vernez, Krop, and Rydell (1999) give a more individual explanation of the benefits of a college degree:

For every native-born Mexican woman who graduates from high school instead of dropping out, the nation would save \$2,438 in social programs and would add \$1,843 in public revenues in her 30<sup>th</sup> year. Similar savings and increases in public revenues would accrue annually over her lifetime. In addition, this woman would enjoy \$2,588 more in disposable income during her 30<sup>th</sup> year. If this woman were to attend some college instead of stopping at high school, the result would be \$956 more in program

savings, \$1,398 more in public revenues, and \$2,401 more in disposable income at age 30. And graduating from college would add another \$411 in program savings, \$2,551 in public revenues, and \$3,722 in disposable income. (p. 30)

Although the exact numbers of these statistics have inevitably changed since 1999, they make a compelling case for continual improvement and attention to educational equality. In order to save money on public social programs, increase the tax base, and improve quality of life, American society must invest more resources into educating Latinas so they are better prepared for the workforce.

### **Problem Statement**

The educational equality of females, Latinos, Native Americans, and African Americans is of the utmost importance given the potential opportunities for societal advancement. Likewise, the need to educate more Americans in STEM fields to develop a workforce capable of meeting the demands of the growing technology-based global economy is also essential. Given these challenges, the researcher limited the scope of this study to specifically examine the retention, persistence, and graduation of Latinas in the field of engineering. Though considerable progress has been made toward gender parity in biological and natural sciences, females continue to be grossly underrepresented specifically in the fields of engineering and computer science (United States Department of Education, [2006], as cited in National Science Foundation, 2009a; United States Department of Education, [2006], as cited in National Science Foundation, 2009b). To meet the demands of a rapidly growing global market, further research is needed to advance the STEM achievement of women from a Hispanic

background—an ethnicity that accounted for more than half of the population growth in the U.S. since 2000 (Fry, 2008; Humes et al., 2011).

Considerable research has addressed the retention of students. Whether focusing on the attrition of minority students, all students in the STEM fields, or another targeted population, most retention studies investigate why students leave a field of study or an institution. Alternately, this study examined why successful students persisted in their chosen major. The field of positive psychology guided this choice, which claims that “a psychology of positive human functioning will arise that achieves a scientific understanding and effective interventions to build thriving in individuals, families, and communities” (Seligman & Csikszentmihalyi, 2000, p. 5). Through the exploration of the strengths of Latina persisters, this research sought to inform efforts to build on those positive characteristics and experiences. As a result, the researcher aimed to guide engineering administrators to make data-driven decisions to address the expressed needs of the Latina population, rather than providing solutions that deal with their needs as assumed by the administration.

The desired outcome for this study was to identify shared characteristics and experiences of Latina students that influenced their persistence in engineering. With this data, academic practitioners and administrators in Engineering at ASU would be better informed to make decisions about the allocation of resources to educational programming and support systems for Latina students. Furthermore, the researcher sought to identify best practices from these experiences so that activities offered by the Ira A. Fulton Schools of

Engineering may be adapted to improve the retention and undergraduate graduation rates of Latinas in engineering and computer science. The primary goal of the study was to inform the researcher's community of practice in Engineering at ASU; however, results of this research may have secondary value to other communities by spurring research for other underrepresented populations.

### **Research Questions**

There are two research questions that guided this study: 1. What are the characteristics of successful Latina persisters in engineering? For the purposes of this study, characteristics may include traits that are developed over time or natural, intrinsic attributes. 2. How do the experiences of Latina students influence their persistence toward a bachelor's degree in engineering? These experiences may have molded the students' characteristics or may have directly influenced their decisions to persist. The researcher solicited an understanding of any relationship that existed between the students' characteristics, experiences, and persistence.

### **Community of Practice**

A growing body of research has looked at the perceptions, culture, curriculum, and pedagogy that impede women and underrepresented ethnic minorities in engineering and computer science (e.g., Baker, 2010; Ceci & Williams, 2007; Hall & Sandler, 1982; Margolis & Fisher, 2003; Seymour & Hewitt, 1997; Tonso, 2007). However, limited research has exclusively focused on Latinas in engineering. This study explored the characteristics of successful Latina undergraduate students who persisted in engineering from their first

semester in Fall 2008 through the Spring 2012 semester and investigated how their experiences have influenced their persistence in engineering at Arizona State University (ASU). ASU is one of three public universities in the state of Arizona. In the Fall 2009 semester, enrollment grew to over 68,000 students, with over 80% of those students enrolled at the main Tempe campus (Arizona State University, 2010a). This was the largest freshman class of any American institution in Fall 2009. In recent years, ASU has worked toward a mission to become the New American University, which is

[t]o prove that a university can be simultaneously excellent and broadly inclusive; that it should engage in use-inspired, as well as curiosity-driven, research; and that it can take significant responsibility for the economic, cultural and environmental health of the communities it serves. (Arizona State University, 2010a)

This dedication to diversifying its student body and promoting research that benefits the surrounding community made Arizona State University an ideal setting for this study.

Throughout the past 10 years, ASU has worked diligently to increase the diversity of its student body. In 2002, only 75 National Hispanic Scholars (NHS) enrolled at ASU. Consistent efforts to partner with the Latino community resulted in the Hispanic student population increasing to 14.6% and 362 NHS enrolling at ASU in 2009. In the 2006-2007 academic year, Arizona State University ranked among the top 25 institutions awarding bachelor's degrees to Latinos by awarding 11% (819 of 7,282) of its bachelor's degrees to Hispanics (National Center for Education Statistics, 2006-2007, as cited in Santiago, 2008a). However, ASU ranked 17<sup>th</sup> among American institutions awarding bachelor's

degrees in engineering to Latinos by awarding 61 degrees to Hispanics, a mere 10.9% of the 559 undergraduate degrees conferred to engineering students (National Center for Education Statistics, 2006-2007, as cited in Santiago, 2008b). Though ASU is a predominately white institution (PWI), ethnic minorities comprised approximately 29.9% of the total student body in Fall 2010 (Arizona State University, 2010a).

According to the Pew Hispanic Center, Hispanics account for more than half of the overall population growth in the United States since 2000 (Fry, 2008). From 2000 to 2007, the Hispanic population of the United States increased by 29%, while the non-Hispanic population increased by only 4%. Looking at the community surrounding ASU, Hispanics comprise 31% of Arizona's population (Pew Hispanic Center, 2009). Furthermore, 32% of Hispanics ages 17 and younger in Arizona live in poverty and the median income of Hispanics is over \$10,000 less than the median income of non-Hispanic Whites in Arizona. Because this rapidly growing population struggles economically and earns such a proportionately low percentage of degrees, it is even more important for higher education administrators to conduct use-inspired research, as encouraged by the New American University model, to focus on the retention and persistence factors of the Latino community. Boosting the educational achievement of Hispanics and females will serve the Arizona community and economy by expanding a sector of the workforce trained to meet the needs of Honeywell, Intel, Boeing, Raytheon, and the other technology-driven companies in Arizona.

## **Researcher**

Over the last several years, one-year retention rates of both females and Hispanics within the Ira A. Fulton Schools of Engineering have ranged from 58-70% (Arizona State University, 2012). Furthermore, only 46% of the females and 38% of the Latinos who entered Engineering at ASU as freshmen in the Fall 2004 semester graduated with an Ira A. Fulton Schools of Engineering bachelor's degree by 2011. Given these dismal statistics, administrators have affirmed that every staff and faculty member, especially those on the Academic and Student Affairs team, play a role in the retention of students within the Ira A. Fulton Schools of Engineering. As the Executive Coordinator for Academic Administration, the researcher plays a seminal part in the efforts to retain and successfully graduate students.

The primary function of the researcher's position is to coordinate the Ira A. Fulton Schools of Engineering scholarship process that awards over \$800,000 annually to undergraduate students. Many of these scholarships are targeted at female and underrepresented students, so the researcher has had the opportunity to directly observe the positive opportunities that financial assistance provides for these students. The researcher is also responsible for coordinating the Engineering Undergraduate Teaching Assistant (UGTA) program and for developing and delivering a series of success workshops targeted at all students seeking assistance with goal setting, time management, and study skills. With this study, the researcher sought to gain more insight about the role of these

programs in the persistence and success of Latina students and to discover how new ideas can be implemented to expand the current reach of these initiatives.

In addition to her professional position in Engineering at ASU, the researcher has a personal connection to the study since she is a non-persister in the field of mathematics. She chose to discontinue her pursuit of a bachelor's degree in math in the third quarter of her sophomore year. In reflection, she did not believe she had the cognitive ability to fully grasp the material, had disappointing experiences with the instructors of her math courses, was paralyzed by the stigma of asking for help, and did not value the payoff of the degree in relation to the amount of difficult work. Although she regrets not earning a bachelor's degree in math, her Bachelor of Science in planning, public policy, and management provided a background through which she explored educational policy issues. Furthermore, the researcher is pleased that her professional path has led to helping students avoid the challenges and pitfalls that she encountered.

Although the researcher identifies with study participants as a female and as a STEM non-persister, she has a weaker connection to their ethnic identity. As a white woman, the researcher does not have intimate knowledge of the Latino culture, nor does she know what it is like to identify as a Latina woman. While it was somewhat difficult to gain trust and access into the Latino community, the different ethnic identity of the researcher brought two benefits to the research. First, as an outsider to the community, she was able to identify and explore the cultural nuances that could be overlooked by someone with a deeply rooted background in the Latino community. Second, as a member of the ethnic



majority in engineering, she was able to serve as an ally and to bring a credible voice to a population that may otherwise not be heard.

### **Theoretical Lens**

Given the facets of the study topic and the corresponding research, several theories influenced the researcher's framework and approach. Because the overarching theme focuses on retention, Tinto's (1993) Longitudinal Model of Institutional Departure gives insight about why students persist or dropout. In this model, a student's pathway to their departure decision consists of six characteristics. Prior to entering the university, students develop pre-entry attributes. These skills and abilities then help to cultivate the student's goals and commitments to college and the workforce. During their postsecondary enrollment, the student encounters a variety of institutional experiences in the academic and social system, which then shapes their academic and social integration in the institution. This integration influences the student's original goals and commitments, which results in a decision about whether to depart from college. Because the researcher was not focusing on the attrition of students at the university level, but rather the loss of students within the field of engineering, Tinto's model was not an adequate lens through which to address the research questions.

Approaching the topic from a different perspective, career decision-making theory provides knowledge about how students choose a specific career path like engineering. Learning Theory of Career Counseling (Mitchell & Krumboltz, 1996) identifies four factors that influence the career development

process. Genetic endowments and special abilities include inherited qualities that may set limits on career options or offer incentives to pursue a given discipline. Environmental conditions and events are often factors beyond one's control that influence skill development and career preferences. Learning experiences usually give students negative or positive reactions to situations or opportunities that previously did not offer any emotional connection. And finally, task approach skills are developed and honed over time as a result of the student's experiences (Mitchell & Krumboltz, 1996). While each of these components plays an integral role in a student's decision to pursue a career in engineering, the model does not build upon the influences of pursuing a postsecondary education.

Consequently, Eccles et al.'s (1983) Expectancy Value Model accommodates for a student's decision to specifically pursue an engineering education, while incorporating many of the factors that attribute to the achievement of underrepresented populations. Figure 1 exhibits the considerations that play a role in Eccles et al.'s Expectancy Value Model of Achievement-Related Choices.

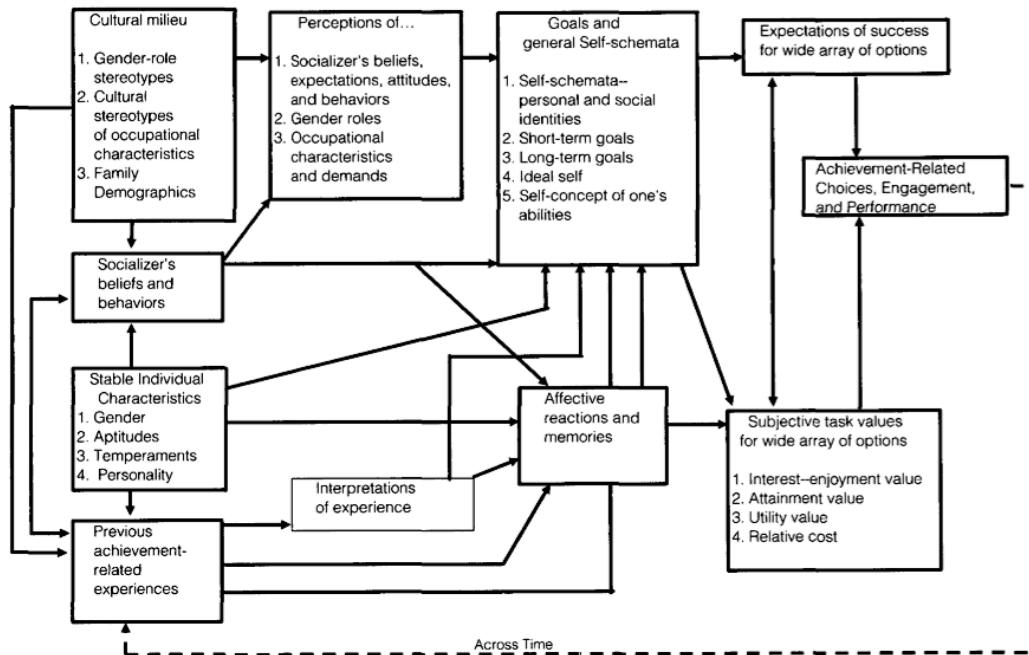


Figure 1. Eccles Expectancy Value Model of Achievement-Related Choices

In creating this model, Eccles draws on work associated with decision-making, achievement theory, and attribution theory. Eccles (2007) asserts that the educational and vocational decisions that potentially contribute to the gender differences in engineering are most influenced by expectations for success and the importance or value that one assigns to the available education and career options. Further, self- and task-related beliefs are influenced by cultural norms, experiences, aptitudes, and universal personal beliefs. The model also blueprints that the “subjective task value,” or the personal value one assigns to an option like choosing a major, is composed of four components:

[I]nterest value (the enjoyment one gets from engaging in the task or activity), utility value (the instrumental value of the task or activity for helping to fulfill another short- or long-range goal), attainment value (the link between the task and one’s sense of self and identity), and cost (defined in terms of either what may be given up by making a specific choice or the negative experiences associated with a particular choice). (Eccles, 2007, p. 202)

The relationships outlined between pivotal influences on decision making create a natural schema through which to approach this study. Eccles et al.'s (1983) model accommodates the foci on engineering and underrepresented populations and was used to frame the literature review and interview protocol in this study.

## CHAPTER 2

### LITERATURE REVIEW

Little research has specifically focused on Latinas in engineering. Therefore, the researcher has woven together threads of research that examine gender parity in the STEM fields, issues faced by underrepresented ethnic minorities in higher education, and general inquiries in engineering and other STEM fields. This literature review addresses the historical and current landscape of Latinas in engineering, the factors that impede the success of underrepresented populations in engineering, the programs and activities that address these barriers, and the theories that surround engineering persistence issues. In addition to reviewing previous studies on success activities offered at other postsecondary institutions, the researcher also reviewed literature that provided a detailed portrait of the research, programs, and student demographics in Engineering at ASU.

#### **Latinos in Higher Education**

Despite the rapidly growing Latino population in the United States, there is a substantial and unresolved educational attainment gap. This gap is especially noticeable when examining the entire educational pipeline from elementary through postsecondary education. According to Padilla (2007):

- For every 100 Latino elementary school students, 48 drop out of high school and 52 graduate from high school.
- Of the 52 who graduate from high school, 31 enroll in college.
- Of the 31 total who enroll in college, 20 go to a community college and 11 go to a four-year institution.
- Of the 20 who go to a community college, 2 transfer to a four-year college.

- Of the 31 who enrolled in college, 10 graduate from college.
- Of the 10 who graduate from college, 4 earn a graduate degree and less than 1 earns a doctorate. (p. 2)

While students drop out of the educational system at every level, attrition often goes unnoticed because of the *revolving door syndrome* (Haro, Rodriguez, & Gonzalez, 1994). This phenomenon occurs when Latino students enter the educational system, drop out, and are replaced by other Latino students, giving the false impression of stability since enrollment numbers remain constant.

Several researchers (Hernandez, 2000; Hurtado & Kamimura, 2003; Padilla, 2007; Rendon, Nora, Cabrales, Ranero, & Vasquez, 2008) have identified key factors that contribute to the postsecondary attrition and persistence of Latino students. Growing up in poverty, attending poorly funded schools that provide limited academic preparation, not participating in early childhood programs, having limited English proficiency, and lacking a network of information about college are among the primary reasons that Latino students are disadvantaged in the educational arena. Similarly, family support and encouragement, academic performance, transition to college, educational goals, campus climate, financial assistance, validation and encouragement, and sense of purpose/self-worth are many factors that positively and negatively contribute to Latino students' retention. Beyond these components, Hernandez (2000) cited the desire to succeed as the single most influential factor that contributes to the persistence of Latino college students.

As a result of these findings, Hurtado and Kamimura (2003) provide several principles for improving postsecondary degree attainment rates among

Latino students. First, they suggest that postsecondary institutions must increase participation rates to develop a Latino presence on campus, as high-achieving Latino students tend to perceive a more welcoming environment at institutions with higher Latino student enrollments. Hurtado and Kamimura also recommend fostering peer mentor support systems to share “college knowledge” among first-generation Latinos (p. 144) and promoting faculty mentoring programs so that Latinos can share their success strategies for overcoming the challenge of being “one of the few” Latinos in higher education (p. 147).

### **Latinas in Science, Technology, Engineering, and Math**

Females and Hispanics are among the populations who are underrepresented in engineering undergraduate degree attainment in the United States. According to the Integrated Postsecondary Education Data System Completions Survey (IPEDS), in 2006, women earned 57.8% of all bachelor’s degrees, but only 19.5% of the bachelor’s degrees in engineering (United States Department of Education, [2006], as cited in National Science Foundation, 2009a; United States Department of Education, [2006], as cited in National Science Foundation, 2009b). Similarly, Hispanics (male and female) earned 7.8% of all bachelor’s degrees and only 7.2% of bachelor’s degrees in engineering. Overlapping both of these data sets reveals that Latinas (female Hispanics) earned only 1.7% of all engineering bachelor’s degrees. Table 1 provides a summary of American engineering degrees awarded to females, Hispanics, and female Hispanics broken out by discipline.

Table 1

*Engineering Bachelor's Degrees Awarded to Females and Hispanics in the United States by Discipline, 2006*

	All	Female (all ethnicities)		Hispanic (all gender)		Female & Hispanic	
		#	% of total	#	% of total	#	% of total
Chemical Engineering	4,857	1,678	34.5	345	7.1	174	3.6
Civil Engineering	10,663	2,422	22.7	952	8.9	255	2.4
Electrical Engineering	19,851	2,571	13.0	1,528	7.7	246	1.2
Mechanical Engineering	16,175	2,107	13.0	1,049	6.5	164	1.0
Other Engineering	16,575	4,522	27.3	1,014	6.1	327	2.0
TOTAL Engineering	68,121	13,300	19.5	4,888	7.2	1,166	1.7

*Note.* Adapted from United States Department of Education, [2006], as cited in National Science Foundation, 2009a; United States Department of Education, [2006], as cited in National Science Foundation, 2009b.

According to the IPEDS Completions Survey, which is administered to institutions across the United States, females have made significant strides in STEM degree achievement over the last 40 years (United States Department of Education, as cited in National Science Foundation, 2008). Women earned less than 25% of all science and engineering bachelor's degrees in 1966. In 2006, women earned slightly more than half of all science and engineering bachelor's degrees (239,273 awarded); however, severe disparities still exist among specific fields. Women earned only 20.5% of bachelor's degrees in computer science and 19.5% of bachelor's degrees in engineering in 2006 (United States Department of Education, [2006], as cited in National Science Foundation, 2009a; United States Department of Education, [2006], as cited in National Science Foundation, 2009b). The Engineering Workforce Commission (EWC) (as cited in National



Science Foundation, 2012) contends that females comprise only 17.2% of all undergraduate students enrolled in engineering programs in 2006.

As a result of this underrepresentation in engineering degree attainment, the presence of women in the engineering workforce is also minimal. Females represent only 9.5% of the nearly 1.5 million engineers employed at the bachelor's degree-level in the United States (Frehill, DiFabio, & Hill, 2008). A 2008 study by the Society of Women Engineers revealed that 71% of men compared to only 61% of women were employed as engineers within three years of graduating with their bachelor's degree in engineering (Freehill, 2010). Furthermore, the study also showed that approximately one-third of women and one-half of men were still employed in engineering jobs 20 years after graduating.

Although females are specifically underrepresented in the field of engineering, Hispanic and Latino students are underrepresented in both STEM fields and within the scope of the entire higher education system. Only 10% of all Hispanics in the United State ages 24 to 64 graduate from four-year institutions (National Center for Education Statistics, 1998). Of the Latino/a students who do enroll at postsecondary institutions, only 46% earn a bachelor's degree. Unfortunately, only a small number of those degrees are in engineering and the percentages are decreasing. In 1995, engineering degrees accounted for 5.5% of the bachelor's degrees awarded to Latinos, which dwindled to only 4.2% in 2005 (Frehill et al., 2008). This shortage becomes even more apparent, considering that Latinos comprise 13.5% of the American labor force, but Latinos employed as

engineers, engineering managers, and technicians account for only 5.8% of the engineering workforce (Frehill et al., 2008).

### **Barriers to Persistence in Engineering**

Most persistence literature aims to determine why students re-enroll (or do not re-enroll) at a postsecondary institution from one year to the next. While this information is important in considering ways to keep underrepresented populations in higher education wherever possible, this literature review specifically addresses why students do not re-enroll in an engineering major, as there is limited research about why students do persist. Some of these barriers inhibit a student's ability to re-enroll at their institution to pursue a bachelor's degree. However, the majority of barriers described specifically negatively affect a female or Latino's persistence in pursuing an engineering or computer science degree. Interestingly, in a longitudinal study of women in science and engineering, 20% of freshman, sophomore, and junior respondents reported no barriers to their achievement, yet nearly all seniors reported at least one barrier (Brainard & Carlin, 1998). It is important to note that the discussed barriers are not an exhaustive list, may or may not apply to students, or may be relevant only at specific points in a student's academic career.

### **Financial Need**

Financial problems are cited as a key obstacle in the persistence of females in engineering (Brainard & Carlin, 1998). In 2001, the median household income of a Hispanic family headed by a member age 45 to 54 (the likely age to have traditional college-age children) was \$41,652. By comparison, white families

with the head of household in the same age bracket had a median income of \$61,643 (U.S. Census Bureau, 2001, as cited in Swail, Redd, & Perna, 2003). This data plainly shows that Latino students need more financial assistance to attend college, and nearly 80% of Latino undergraduate students applied for financial aid in 2003-2004. Close to 63% received some sort of aid for college expenses; however, Latinos received the lowest average financial aid award of any ethnic group. Latinos received an average aid award of \$6,250, compared to the average aid award for all undergraduates of \$6,890 (Santiago & Cunningham, 2005). Within their financial aid package, Latinos were more likely to receive grants than loans. Fifty-three percent of Latino undergraduates who received financial aid were awarded grants, while only 30% received loans (Santiago & Cunningham, 2005). However, these grants may not contribute nearly enough funding for students. Although appropriations for the federal Pell Grant increased by 23% from 1990 to 2000, tuition and fees for four-year public colleges and universities rose by 40% (American Council on Education, 2000; College Board, 2001).

### **The Role of Family**

Family and friends have been found to have a significant influence on the persistence of both female and Latino students. Eccles (1994) conducted a longitudinal study of adolescent life transitions, which revealed that “girls place more value than boys on the importance of making occupational sacrifices for one’s family and on the importance of having a job that allows one to help others and do something worthwhile for society” (p. 600). These findings were further

exemplified with data showing that females rated family, friends, richness of one's cultural life, and joy in living higher than males ranked these attributes (Margolis & Fisher, 2003). Moreover, men rated occupation higher than women. Given this disparity in values, women may be more likely to depart a rigorous field like engineering given a family conflict or if the difficulty of the work impedes on their quality of life.

Like the female population, Latino students have also been “expected to balance the expectations of their parents with those of the college environment” (Torres, forthcoming, as cited in Torres, Howard-Hamilton, & Cooper, 2003). Luckily, the Hispanic culture has become increasingly accepting of the need for higher education. According to Immerwahr (2000), 65% of Hispanic parents identified a college education as “the one thing that can most help a young person succeed in the world today” (p. 5). This shift in outlook is especially important, considering that Latino undergraduates are more likely to live with their parents compared to all undergraduate students. Santiago and Cunningham (2005) state that one-third of Latinos live at home, while less than one-quarter of all undergraduates do. Furthermore, only 7% of Latino undergraduates live on campus, compared to 14% of all undergraduates. Given this important relationship with family, Latino students may become likely to depart a field given familial conflict.

### **Classroom Climate**

In 2007, the Committee on Science, Engineering, and Public Policy stated that “women are very likely to face discrimination in every field of science and

engineering” (p. 3). Unfortunately, discrimination inside the STEM classroom has made it difficult to retain and graduate women in these fields. As early as the 1970s and 1980s, institutions across the nation began to examine how women were treated in the classroom. These studies showed significant trends that created an unwelcoming and less helpful environment for female students that included discriminating classroom gestures, interrupting women more often than men, affirming male students more often than females, and asking female students lower order questions than those asked of male students (Hall & Sandler, 1982).

Over the years, unwelcoming environments for women in STEM have become known as the *chilly* or *chilling climate*. “A chilling classroom climate puts women students at a significant educational disadvantage” (Hall & Sandler, 1982, p. 3). Though first referenced nearly 30 years ago, the chilly climate in higher education still exists and may lead women to believe that their presence in the classroom is unwelcome, their participation in class discussions is not important, the availability of extracurricular support is not available, their aptitude for intellectual development and professional success is limited, and their academic and career goals are not of serious concern. Given the historical oppression of the American Hispanic population, it is easy to see where similar beliefs by Latino students could influence their achievement in the STEM classroom.

### **Departmental and School Climate**

Over the years, researchers have explored the gender biases in informal interactions between students and faculty outside of class and how relationships

between advisors and students affect the retention of female students (Hall & Sandler, 1982). A survey of female science and engineering students at the University of Washington showed that not being accepted into the department and feeling isolated were among the foremost barriers to persistence in the field (Brainard & Carlin, 1998). With these barriers for women in engineering, the “leaky” or “shrinking” pipeline of female students in the STEM fields leads to serious concern and perpetuates the cycle of underrepresentation.

The shrinking pipeline in computer science shows that only 15.6% of assistant professors, 9.4% of associate professors, and 5.7% of full professors in doctoral degree-granting departments are women (Camp, 1997). Similarly, Latinos account for only 3.3% of all faculty in the United States (Frehill et al., 2008). One may argue that this meager number of Latino and female faculty members creates an unwelcoming atmosphere for underrepresented students and provides little encouragement for them to complete their undergraduate studies or continue into graduate programs. Cohoon (2001) found that computer science departments generally retained women at rates comparable to men when the faculty included at least one woman who valued, mentored, and supervised female students; graduating seniors had strong access to a local job market; and there were enough female students in the classes to support each other.

“The College of Engineering Effect” is an interesting phenomenon found specifically among computer science departments (Camp, 1997). Data shows that computer science departments in engineering colleges, on average, graduate proportionately fewer women than computer science departments in non-

engineering colleges. According to data from the National Center for Education Statistics (1998), females earned 26.8% of computer science bachelor's degrees awarded in 1992-1993 from non-engineering schools and only 22.8% of computer science bachelor's degrees from a college of engineering. Moreover, only 11.7% of the bachelor's degrees awarded in computer engineering were granted to women in 1992-1993 (Camp, 1997). However, several institutions like Pennsylvania State University and the University of Washington moved their computer science departments to an engineering college. Consequently, the number of females earning bachelor's degrees in computer science declined at dramatic rates. More research is needed to identify the cultural differences between engineering and non-engineering colleges.

### **Self-Efficacy**

Self-efficacy, as defined by Bandura (1986), "refers to beliefs in one's capabilities to organize and execute courses or action required to produce given attainments" (p. 3). Therefore, self-efficacy plays a role in decisions regarding the amount of effort in a given endeavor, how long to persevere with challenges, how resilient students are after facing obstacles, how coping mechanisms are used in stressful situations, and the level of accomplishment that is self-recognized (Bandura, 1997). Research has shown that self-efficacy is an important factor for women and minorities pursuing engineering or any other career field dominated by males and whites (Brainard & Carlin, 1998).

Female students at the University of Washington referred to feelings of intimidation and lacking of self-confidence as reasons to stop pursuing a degree in

engineering (Brainard & Carlin, 1998). These factors can then manifest into stereotype threat, another factor that contributes to the attrition of women and minorities in STEM fields (Steele, 1997). “When we fear that our actions will confirm negative stereotypes about our ‘group,’ or about ourselves as members of a group, then this ‘stereotype threat’ negatively affects our behavior” (Cohoon, 2008). For example, women may underperform on science exams when gender is called to their attention, or women may avoid taking a leadership role in a project after viewing a commercial or video that shows females in stereotypical feminine behaviors. Due to the negative stereotypes that surround women and minorities’ abilities in the fields of math, science, engineering, and computing, faculty, employers, and the students themselves may consequently expect less of female and ethnic minorities in these fields. Combining the notion of stereotype threat with the unwelcoming culture in STEM fields may help to describe why women and ethnic minorities with average grades are more likely to leave computer science and STEM fields than their counterparts.

### **Lack of Interest in Engineering**

Brainard and Carlin (1998) cite a lack of interest as a prominent factor leading to the attrition of women in engineering. Research shows that girls have equal achievement to boys in math and science classes; however, many females appear to lose interest or become averse to math and science at the high school and postsecondary level (Slashinski, 2004). To address this issue, the Carnegie Mellon Summer Institute for Advanced Placement Computer Science Teachers asked attendees to make two lists—one focusing on why girls enroll in computer



science, the other on why girls do not enroll (Margolis & Fisher, 2003). Among the list of why girls do not enroll, the following were consistently included:

- The course has a geeky reputation, and girls do not want to be associated with that image or with the people in that class.
- [Girls] have broad interests that result in scheduling conflicts, since computer science courses are often taught only in a single period.
- [Girls] find the games that are pervasive in the computer culture boring. (p. 113)

Although this list specifically represents the views of high school girls, these reasons can be applied to college students. Viewing this list within the framework of Eccles' et al. (1983) Expectancy Value Model, the geeky cultural stereotype of the occupational characteristics can influence one's perception of the occupational demands, causing one to lose interest in the field. Or, the relative costs of enrolling in an engineering field may not outweigh the benefits of pursuing another field of interest. In any case, engineering educators must do a better job of educating females and minorities at all levels about what engineering is, what engineers do, and the impact of engineering on society in order to bolster interest in the field.

### **Persistence Strategies and Solutions**

The rise of student affairs in higher education introduced a variety of involvement and success initiatives across campuses. Housing facilities began to offer academic support and opportunities for engagement, academic advising staff were hired to help guide students' course selections, and university staff developed extracurricular research, service, and social organizations. Though many of these services were centrally offered by the university, in recent years

many of these resources have been disaggregated and relocated into specific schools or programs. These school-centric models are able to foster connections between students in specific disciplines and offer customized support services that meet the needs of students in a particular field. STEM programs have been especially successful in offering these specialized services to achieve higher retention and achievement rates of science, math, and engineering students.

### **Peer Networks and Support**

Uri Triesman, a former professor at the University of California, noted that African American students had a high failure rate in calculus. He observed that “Asian American students formed social communities in which they helped each other with math, competed at mastering the material, and generally supported each others’ learning,” but African American students were academically removed from other students and did not form learning communities with their peers (Margolis & Fisher, 2003, p. 104). As a result, Triesman organized communities for the African American students that were modeled after the communities formed by Asian American students. The groups focused on a problem set built to encourage interaction and foster a supportive learning environment. Since then, similar programs have developed across the country that boast high retention rates in calculus among African American and Hispanic students (Margolis & Fisher, 2003).

Triesman’s learning communities are one example of an academic group designed to provide peer support. However, learning communities can be developed through a variety of means. Students can build academically

supportive relationships with their peers through student clubs and organizations, self-organized study groups, and residential communities. College persistence literature consistently shows that living on campus increases the probability of degree completion (Astin, 1993). This is true because students from the same discipline who live together are able to form study groups, develop an informal support network, and have easier access to on-campus resources, all of which promote persistence in difficult fields like engineering.

### **Relationships with Faculty and Staff**

Research shows that the academic climate is important in the attrition of women from the science, technology, engineering, and math fields (Committee on Science, Engineering, and Public Policy, 2007). “According to most of our female participants, it is critical to find faculty, advisers, or counselors to provide guidance, support, and encouragement at an early stage and throughout their program of study” (Starobin & Laanan, 2008, p. 44). Similarly, a study by Brainard and Carlin (1998) found that a sense of belonging within the department and the positive influence of faculty members, an advisor, and a mentor in math and science ranked among the primary factors that influenced a female student’s decision to continue in science and engineering (Brainard & Carlin, 1998).

Capitalizing on the research that shows the importance of interdependence, the Gateway Engineering Education Coalition at Drexel University adopted two “train-the-trainer” types of programs: the Women’s Leadership Series and Getting Plugged-In (Fromm, 2002). The Women’s Leadership Series develops leadership and career fulfillment objectives for female

faculty and students, while Getting Plugged-In targets minority students and facilitates faculty/student relationships, introduces students to building networks, and encourages female students to pursue pre-professional engineering opportunities. With the help of these programs and the added efforts of faculty and staff in the schools, the Gateway cohort experienced retention rates of 86%, compared to a rate of 70% of the national sample of all students. Additionally, retention rates of females and underrepresented minorities improved:

“For women, the first year retention data for Gateway Schools is 90% versus 68% for [STEM] schools in the national study...Retention rates from second to third year have increased 18% to 20% respectively and the percentage of the graduating class awarded BS degrees in Engineering has increased by 113% for underrepresented minorities and 54% for women” (Fromm, 2002, p. 10).

The Gateway Engineering Education Coalition is just one example of a program that fosters beneficial relationships between students and faculty to improve retention rates.

### **Financial Support**

The National Action Council for Minorities in Engineering (NACME) (2009) has been responsible for more than \$4 million in scholarships that are awarded annually to underrepresented minority students in engineering. NACME provides block grants to universities to provide scholarships for African American, American Indian, and Latino students enrolled in engineering programs. The primary goals of the program are to increase the entry-to-graduation rate of ethnic minorities enrolled at partner institutions and to increase the institutions' ability to recruit, admit, retain, educate, and graduate minority

engineers. Since the mid-1990s, NACME scholars have surpassed an 80% retention-to-graduation rate. This rate is twice the national average for minority student retention in engineering and almost 20 percentage points higher than the retention rate of all engineering students, regardless of ethnicity (National Action Council for Minorities in Engineering, 2009).

On a larger scale, research about the relationship between persistence and financial aid has been inconsistent. Although several studies have found no significant link between financial aid and persistence, Lichtenstein (2002), who looked at the persistence of Hispanic students, and Pascarella and Terenzi (2005) found that working in a work-study position had a direct, positive effect on persistence. “In addition to providing financial support, work-study also gives students opportunities to interact with administrative staff and faculty members, enhancing their students’ social and academic integration” (Pascarella & Terenzini, 2005, p. 410). However, it is unclear whether the positive effect on persistence should be attributed to the financial assistance, as some research shows that persistence is a common outcome when the student’s employment is related to the academic interests (Pascarella & Terenzini, 2005).

### **Internships and Co-ops**

The National Commission for Cooperative Education defines cooperative education as “a structured educational strategy integrating classroom studies with learning through productive work experiences in a field related to a student’s academic or career goals” (National Commission for Cooperative Education Practitioners Committee, 1994, p. 1). According to Brainard and Carlin (1998), a

student's involvement in internships and co-ops becomes a significant factor in female students' persistence at the end of their sophomore year and beginning of their junior year.

Kuntz (2009) conducted an action research study to explore the relationship of required cooperative education on female students' choice of and persistence in undergraduate engineering programs at The University of Toledo. Kuntz found that mandatory co-op programs reinforced the decisions of female students to pursue and persist in engineering. One study participant explained that the "[co-op] reassured my parents that I would get some experience, therefore, having a better chance at having a job when I graduated" (Kuntz, 2009, p. 48). In addition to relieving familial pressures, Kuntz also found that the co-op experiences showed female participants that engineering is more than theory and helped them to enjoy the work of engineers through first-hand experience, which dissuaded the participants from changing their major out of engineering.

### **Engineering at ASU**

ASU and the Ira A. Fulton Schools of Engineering have had limited success in retaining and graduating female and Latino students. The one-year retention rate of female engineering first-time full-time freshmen (FTFTF) at the university increased from 92.4% in Fall 2007 to 94.2% in Fall 2008, but fell to 90.3% in Fall 2009 and 90.6% in Fall 2010. The one-year retention rate of Hispanic engineering first-time full-time freshmen (FTFTF) at the university remained constant around 85%, except for the 2007 cohort which dropped nearly 10% (Arizona State University, 2012). Tables 2 and 3 compare the first-year

persistence rates of female and Hispanic FTFTF entering the Ira A. Fulton Schools of Engineering from 2006 to 2010.

Table 2

*One-Year Persistence Rates for Female First-time Full-time Freshmen in Engineering*

	2006		2007		2008		2009		2010	
Entered into Engineering	125		144		172		186		192	
	2007		2008		2009		2010		2011	
Enrolled in Engineering	81	65%	100	69%	125	73%	123	66%	143	74%
Enrolled in Other College	25	20%	33	23%	37	22%	45	24%	31	16%
Not Enrolled	19	15%	11	8%	10	6%	18	10%	18	9%

Table 3

*One-Year Persistence Rates for Hispanic First-time Full-time Freshmen in Engineering*

	2006		2007		2008		2009		2010	
Entered into Engineering	105		101		169		159		217	
	2007		2008		2009		2010		2011	
Enrolled in Engineering	73	70%	59	58%	113	67%	106	67%	150	69%
Enrolled in Other College	16	15%	18	18%	34	20%	28	18%	32	15%
Not Enrolled	16	15%	24	24%	22	13%	25	16%	35	16%

*Note.* Adapted from “Ira A. Fulton Schools of Engineering: Persistence and Graduation Rates for First-time Full-time Freshmen,” by Arizona State University, 2012. Copyright (2012) by Arizona State University Office of Institutional Analysis.

From 2006 to 2010, the number of admitted students from the female and Hispanic populations and the one-year retention rates of these students fluctuated. First-year persistence rates of females within the Ira A. Fulton Schools of Engineering ranged from 65% to 74%, while one-year retention rates for

Hispanics ranged between 58% and 70%. Although the focus of this study looked at persistence within the Ira A. Fulton Schools of Engineering, it is important to note that students who “immigrate” or “defect” to other colleges at ASU or who do not re-enroll at ASU may have enrolled in an engineering major in the College of Technology and Innovation at ASU or in an engineering discipline at another postsecondary institution.

According to the Fall 2009 Former Arizona State University Freshman Survey (Engineering Students), 133 first-time freshmen in the Ira A. Fulton Schools of Engineering Fall 2008 cohort who were eligible to return in Fall 2009 did not (Arizona State University, 2010b). One hundred two of these students responded to the survey, generating a response rate of 77%. Of the respondents, only 10% were female and 19% were Hispanic (these classifications are not mutually exclusive). These statistics are particularly interesting considering the makeup of the overall ASU former freshman respondents was 47% female and 16% Hispanic. Survey respondents were asked to select three primary reasons why those chose to leave ASU. “[T]he top three reasons why Engineering non-persisters reportedly chose to leave ASU were: financial reasons (69%), personal reasons (27%), and to be closer to home (24%)” (Arizona State University, 2010b, p. 5), all of which aligned with the reasons given by the entire cohort of freshman non-persisters at ASU. Additionally, 130 first-time full-time freshmen who entered in Fall 2008 transferred out of the Ira A. Fulton Schools of Engineering into other majors at ASU (Dickson, 2010). Approximately 50 (38.5%) of these students stayed in a STEM field, as 43 transferred into science



and math majors in the College of Liberal Arts and Sciences and 6 transferred into a STEM major in the College of Technology and Innovation.

Though the retention of students in their first year is a good predictor of their future persistence, the overarching goal of all postsecondary institutions is to graduate students. Of the 2004 cohort of first-time full-time freshmen in the Ira A. Fulton Schools of Engineering, only 147 students (19.2%) were female and 103 students (13.5%) were Hispanic (Arizona State University, 2012).

Shockingly, only 46% of the female students and 38% of Hispanic students in this cohort graduated with a bachelor’s degree in engineering or computer science after seven years (by Fall 2011). Table 4 provides a detailed overview of the female and Latino achievement within the cohort admitted in 2005.

Table 4

*Persistence and Graduation Rates for First-time Full-time Freshmen in Engineering*

	Females (N=147 in Fall 2004)				Hispanics (N=103 in Fall 2004)			
	After 1 year (Fall 2005)		After 7 years (Fall 2011)		After 1 year (Fall 2005)		After 7 years (Fall 2011)	
Graduated in Engineering	0	0%	67	47%	0	0%	39	38%
Enrolled in Engineering	105	71%	0	0%	65	63%	1	1%
Graduated in Other College	0	0%	43	29%	0	0%	24	23%
Enrolled in Other College	29	20%	4	3%	17	17%	5	5%
Not Enrolled	13	9%	33	22%	21	20%	34	33%

*Note.* Adapted from “Ira A. Fulton Schools of Engineering: Persistence and Graduation Rates for First-time Full-time Freshmen,” by Arizona State University, 2012. Copyright (2012) by Arizona State University Office of Institutional Analysis.

Like the efforts of institutions previously described in this chapter, engineering schools across the nation are implementing an assortment of “engineering plus” activities to increase the enrollment and retention of students in an engineering discipline. As coined by administrators in the Ira A. Fulton Schools of Engineering at Arizona State University, engineering plus activities are “[v]alue-added initiatives that greatly enhance the quality of our students’ undergraduate experience. Examples include undergraduate research opportunities, entrepreneurial training and experiences, service learning, and the participation of our student organizations in national and international competitions” (Arizona State University, 2010c, p. 7). These educational experiences strive to create a support network of faculty, staff, and other students and to engage undergraduate students in hands-on engineering activities outside of the classroom, but within the larger engineering community (see Appendix A for a detailed list of engineering plus programs offered through the Ira A. Fulton Schools of Engineering).

The Ira A. Fulton Schools of Engineering have conducted limited quantitative analysis to identify a correlation between involvement in engineering activities and retention rates. Students who live in the Engineering Residential Community are retained at a slightly higher rate than the entire population of first-year students (3.6% increase). However, one-year retention rates of females and underrepresented ethnic minorities who lived in the Engineering Residential Community were significantly higher (14.7% and 8.9% increase, respectively). Similar to residential students, students who participated in the fall 2008 E2

Camp, a three-day camp in Prescott, Arizona for all incoming first-time freshmen in engineering, were retained at a rate 9% higher within the University and 7% higher within engineering than students who did not attend E2 Camp (Arizona State University, 2010c).

## CHAPTER 3

### METHODOLOGY

The purpose of this study was to understand the characteristics of successful Latina persisters in the Ira A. Fulton Schools of Engineering and how the experiences of these students influenced their persistence toward a bachelor's degree in engineering. To achieve these outcomes, this study utilized a qualitative, action research approach.

#### **Theoretical Framework**

Corbin and Strauss (2008) contend that the research question of a study should dictate the methodological approach used to conduct the research. Given the limited research that focuses specifically on Latinas in engineering, the researcher had a foundational knowledge of the population developed through the existing research on Latinos in higher education, underrepresented minorities in STEM, and retention in engineering. Her knowledge of this research was coupled with her experience working with underrepresented STEM students in her previous professional position and engineering students in the position she held at the time of this study. Therefore, the researcher needed an exploratory approach to gather data about this previously untargeted student population.

The researcher developed two open-ended research questions that explored the participants' traits, experiences, and decision-making processes in relation to their educational experiences in engineering. This focus was an appropriate groundwork for the first thorough examination of Latinas in engineering so that engineering administrators could improve retention efforts

with a better understanding of these students' backgrounds, what initially motivated them to pursue a bachelor's degree in engineering, and what experiences positively and negatively affected their persistence. As a result, the researcher used a qualitative approach to address the research questions and guide the data collection.

Qualitative methods allow researchers "to get at the inner experience of participants, to determine how meanings are formed through and in culture, and to discover rather than test variables" (Corbin & Strauss, 2008, p. 12). These components are demonstrated in this study through the researcher's pursuit to discover how the characteristics and experiences of Latina students contribute to their persistence within the culture of engineering. As described in the second chapter, the culture of engineering has traditionally been unwelcoming and unfriendly to females and underrepresented ethnic minorities. While this study further informed the researcher's knowledge of the culture of engineering, the focus of this study was to explore the participants' experiences within the culture of engineering, not to explore the culture itself. "Qualitative research is a means for exploring and understanding the meaning individuals or groups ascribe to a social or human problem" (Creswell, 2009, p. 4). Beyond the problem of high attrition rates of Latinas in engineering and computer science, it was necessary for the researcher to understand how Latinas respond to the culture of engineering, which pushes many students away, but also fosters success for others. To further understand how the engineering culture can cultivate or dissuade Latina persisters, it is most beneficial for administrators to invest in students who have successfully

navigated and persisted in the field of engineering, rather than to focus on the non-persisters.

In order to most effectively secure the individual students' stories, the researcher needed to meet participants at their developmental level. Baxter Magolda and King (2007) assert that college-age students self-author their epistemological beliefs, along with their interpersonal and intrapersonal self. This means that students are consistently developing and building upon their belief system, the way they gather knowledge, and their worldview through their interactions with the environment around them. Because the researcher used qualitative methods at a time when students were actively forming their identity and shaping their personal values, the participants may have been better able to identify the people and experiences that influenced the developmental process they were experiencing at the time of data collection. This permitted the researcher to elicit data that allowed participants to benefit from self-reflection (Lather, 1986), in addition to building a narrative that presented the experiences of participants as they lived them in a format that was also accessible to the Engineering at ASU administrators (Denzin, 2001).

The researcher approached her exploration of the phenomenon through a constructivist framework, because she is drawn to the storytelling nature of qualitative research. Instead of gathering data using methods that claim to have a standardized meaning for everyone, the researcher found more value in listening to the unique experiences of every individual with a different background and set of lived experiences. She believes in a reality that is socially constructed, and that

each person creates his or her own knowledge and meaning through the interpretation of their unique experiences (Creswell, 2009). Knowledge is “socially constituted, historically embedded, and valuationally based” (Hendrick, 1983, p. 506, as cited in Lather, 1986, p. 259). The goal of research through a constructivist lens is to present the participants’ views and knowledge and to build these subjective meanings into a detailed portrayal of the phenomenon (Creswell, 2009). Like others (e.g., Denzin 2001), the researcher believed that accessing this understanding of meaning is best captured through participant stories.

While the researcher sought to gain a deeper understanding of the phenomenon by collecting data that provided a “thick description” of the experiences of undergraduate Latina students in engineering (Geertz, 1973), a constructivist researcher must also interpret the data that she collects.

“Interpretive interactionism attempts to make the meanings that circulate in the world of lived experience accessible to the reader. It endeavors to capture and represent the voices, emotions, and actions of those studied” (Denzin, 2001, p. 1). This method of understanding is particularly ideal because the voices, emotions, and actions of Latinas have yet to be presented or acknowledged within the field of engineering. Moreover, interpretive research is “concerned with the social construction of gender, power, knowledge, history, and emotion” and offers insight into the history, persistence, and methods of addressing social problems (Denzin, 2001, p. 39). By collecting and presenting a thorough interpretation of the experiences surrounding the persistence of Latinas in engineering, the researcher was better equipped to address the problem of Latina attrition in

engineering. The researcher used the lens of interpretive interactionism to provide transparency in the presentation of the researcher's personal values and to explore the relationship between the problem of Latina attrition in engineering and an institution that perpetuates the obstacles faced by these students.

### **Action Research**

Similar to Auerbach and Silverstein (2003), the researcher sought “to *change* the world, not simply to *describe* it,” (p. 125) and subsequently used an action research approach. Argyris and Schon (1991) break action research into two functions: 1. *action*, to improve current practices or prompt culture changes, and 2. *research*, to produce knowledge about a phenomenon. Given the poor Latina degree attainment in engineering, it was the researcher's goal to provide the engineering administration at ASU with a better understanding of the factors that contribute to the persistence of Latinas in engineering. With that knowledge, the researcher hoped to influence policies and practices within the Ira A. Fulton Schools of Engineering to create a learning environment that improves the retention and graduation of Latinas within Engineering at ASU.

Herr and Anderson (2005) define action research as “inquiry that is done *by* or *with* insiders to an organization or community, but never *to* or *on* them” (p. 3). In this study, the researcher was neither an engineer by training nor from an underrepresented ethnic background. However, she was a member of the engineering education community by trade and was concerned with the current trends of minority degree attainment in engineering. By shifting the locus of control from the researcher to the participants, it allowed the students to become



“active subjects empowered to understand and change their situation” (Lather, 1986, p. 265). To assist the participants, the researcher worked with current successful Latina engineering students to gain a better understanding of the phenomenon of their persistence and to identify key themes about their experiences not otherwise evident to the researcher or explored by the community of practice.

As a professional within the Ira A. Fulton Schools of Engineering, the researcher felt it was imperative to demonstrate an *ethic of care* and to listen to the expressed needs of the students who are being served (Noddings, 2005).

Noddings explains the ethic of care:

If my expressed needs are not treated positively, or at least sensitively, I will likely not feel cared for. Attempts to care frequently misfire this way. Would-be carers think they know what the cared-for needs and act on their inferences in the name of caring. (Noddings, 2005, p. 148)

In higher education, administrators often implement initiatives based on the perceived or inferred needs of a population or because a similar program has had success in another area. As Noddings discusses, there is a distinct difference between the expressed and inferred needs of students. This study served as an opportunity for Latina students to express their needs in a safe forum and to partner with the researcher who can serve as an advocate for change. After completing this dissertation, the researcher may further fulfill her obligations as a scholar-practitioner to ensure that engineering programs and services meet the expressed needs of Latina students and to evaluate if the Schools’ desired value of their efforts is in fact the actual value achieved.

Though she is an insider within the institution, the researcher endeavored to work with the Latina student population to improve the efforts of the Ira A. Fulton Schools of Engineering. The researcher's collaboration with the students at Engineering at ASU administrators brought together a community of stakeholders who care about the issue of Latina persistence in engineering. "Action research is best done in collaboration with others who have a stake in the problem under investigation" (Herr & Anderson, 2005, p. 4). As a professional who chose a career path in higher education, the researcher has a deeply-rooted interest in the success of *all* students. Other faculty and staff in Engineering at ASU may have similar goals to educate and serve the growing Latino population who can then comprise a diversified workforce that contributes to the economic and technical growth of the state of Arizona. Similarly, Latina students commonly seek exemplars who can provide mentorship, expand the engineering pipeline, and create opportunities for other members of the Hispanic community (Anderson-Rowland et al., 1999). Given these goals, one can assume that engineering administrators, current and graduated Latina students in engineering, and members of the engineering workforce all have a vested interest in improving the low achievement rates of Latinas in engineering.

Furthermore, each of these parties served an integral role in the long-term goal of this study—to increase the number of Latinas who graduate with a bachelor's degree in engineering. Having the support of engineering administrators allowed the researcher to access confidential resources that were unavailable to the general public. Unpublished research that examined the

climate in engineering and data that explained the retention rates of specific student groups helped provide the researcher with a more thorough understanding of the culture of Engineering at ASU. Moreover, by asking Latina students in engineering to play an active role in the data analysis and theory building process, the researcher aimed to develop a more thorough and effective case for change in the current structure.

### **Participants**

At the time of data collection, Engineering at ASU employed the researcher as the executive coordinator for academic administration. Therefore, she not only had access to demographic data, academic records, and contact information for all engineering students, but the nature of the research was directly tied to the functions of her position. Obtaining an understanding of the characteristics and experiences of Latina students who persist in engineering would later enable the researcher to modify and develop success-focused programming within the Ira A. Fulton Schools of Engineering with the intention of fostering higher retention rates of Latina students.

The researcher received approval from the Institutional Review Board (see Appendix B) and the Ira A. Fulton Schools of Engineering to conduct two phases of research. In phase one, the researcher used a convenience sample to recruit the participation of two undergraduate Latina engineering students. Both students personally knew the researcher through their involvement in Ira A. Fulton Schools of Engineering programs coordinated by the researcher, and both were admitted as freshmen to the Ira A. Fulton Schools of Engineering in Fall 2007. The

researcher sent a recruitment email (see Appendix C) to the ASU email account of the two students. To maintain the confidentiality of the subjects' identity, participants gave verbal consent after receiving a copy of the Information Letter attached to the email (see Appendix D) and before participating in the interview.

In phase two, the researcher simultaneously conducted individual interviews with seven participants and observed the meetings and activities of a multicultural engineering student organization. Taylor and Bogdan (1984) assert that the "ideal research setting is one in which the observer obtains easy access, establishes immediate rapport with informants, and gathers data directly related to the research interests" (p. 19). This particular student organization provided an ideal opportunity for the researcher to gain exposure to the culture of Latino students in the Ira A. Fulton Schools of Engineering because she was the organization's advisor. As the advisor, the researcher had easy access to all organization events and a working relationship with the student members. According to the organization's website, their objective was to form an organization of professional engineers who could serve as role models for the community. Further, networking was of foundational importance for the organization and they held regular meetings, science nights with local schools, and mixers with industry professionals, in addition to participating in national conferences. This assortment of events allowed the researcher a variety of observation opportunities.

Although the researcher gained her advisor affiliation between the first and second phases of data collection, the unequal power dynamic with members

of the organization was lessened through her prior rapport with several members of the general body and the executive board. The researcher contacted members of the executive board and asked permission to include data collected through her observation of executive board meetings in the study. At the beginning of the observation period, the researcher provided executive board members with an information letter (see Appendix E) that outlined the purpose of the study and the potential risks associated with participating in the observation session. The researcher ensured that her observation did not disrupt the setting by making her advising responsibilities first priority in the meetings. The researcher recorded field notes whenever possible during the meetings and wrote a summary of her observations after each meeting. Additionally, the researcher guaranteed that all observation findings would remain confidential and references to interactions or contributions used in the research findings would not be attributed to any executive board member by name.

To identify interview participants, the researcher queried the ASU PeopleSoft student database for all students whom identified as “female” and “Hispanic/Latino,” were admitted as first-time full-time freshmen in the Fall 2008 semester, and were still enrolled in an Ira A. Fulton Schools of Engineering major as of October 2011. All of the participants were college students between the ages of 20-22 who enrolled at the university within one year of graduating high school.

The researcher chose to interview participants in the 2008 cohort because of the interventions implemented by the Ira A. Fulton Schools of Engineering.

Engineering at ASU adopted more stringent admission standards for the 2008-2009 academic year, held the first E2 Camp for incoming freshmen in the summer of 2008, and required all first-time full-time freshmen to live on-campus in the Engineering Residential Community for the first time in 2008-2009. Of the 44 female Latina students who were admitted to the Ira A. Fulton Schools of Engineering in Fall 2008, only 19 were still enrolled in an engineering discipline three years later at the time of recruitment for this study. Walden and Foor (2008) describe *persisters* as students who were directly admitted and enrolled in a STEM major, *internal resettlers* as students who switched from one STEM major to another, and *in-switchers* as students who began their college career as a non-STEM major and switched into a STEM major later. All interview participants were persisters who were directly admitted to an engineering major.

The researcher emailed a recruitment script (see Appendix F) to the ASU email account of all 19 potential subjects to recruit the participation of at least five students. If fewer than five students initially agreed to participate, the researcher planned to use snowball sampling to solicit participation from students who were hesitant. Seven of the 19 students who were contacted agreed to participate. However, if fewer than five students elected to participate, the researcher planned to have volunteers recruit their peers after building a relationship with the researcher in the first interview, experiencing the self-reflective value of the study, and understanding the larger impact of the research. Students who agreed to participate received a copy of the information letter (see Appendix G) prior to

the first interview and gave verbal consent before participating in each interview to maintain the confidentiality of the subjects' identity.

The researcher chose to interview students enrolled in their fourth year at ASU. Research shows that junior-level students are a reliable representation of persisters, since it is unlikely they will change majors at this point in their undergraduate career (Pascarella & Terenzini, 2005). This research was further exemplified in ASU initiatives, such as critical tracking, which identifies a set of courses, milestones, or Grade Point Averages (GPAs) within the first four semesters to improve graduation rates by allowing students to “degree-shop for alternative majors” during their first two years (Capaldi et al., 2006, p. 49). Due to the higher than average attrition rate in engineering, senior-level students were an even more accurate illustration of persistence to graduation. These students had more than three full years of experience in Engineering at ASU and were able to reflect upon how their personal traits and history of educational experiences influenced and changed the pathway through their engineering education.

Sandelowski (1995) contends that the “[a]dequacy of sample size in qualitative research is relative” (p. 179). Considering the variance among the Latina community, the researcher interviewed a sample of participants who allowed her to achieve informational redundancy (Lincoln & Guba, 1985), or theoretical saturation (Strauss & Corbin, 1990). The researcher chose a theoretical sample of seven students to represent a variety of ethnic backgrounds, Engineering at ASU majors, GPAs, and extracurricular involvement within the data. This sample size allowed the researcher to identify both anomalies and

patterns among the data. Furthermore, seven participants was a manageable size that allowed her to conduct follow up interviews and thoroughly explore the nuanced data that she collected. Additionally, she gained a well-rounded understanding of the experiences and background of every participant and was able to interpret the meaning of each participant’s story within the larger scope of theory development. Table 5 shows the participants’ majors, ethnicities, and residency statuses.

Table 5

*Participants by Major with Demographic Data*

<b>Student</b>	<b>Fall 2011 Major</b>	<b>Heritage</b>	<b>Residency</b>
Gabriela	Aerospace Engineering	Mexican	Non-Resident
Rosa	Chemical Engineering	Mexican	Arizona
Paloma	Civil Engineering	Mexican	Arizona
Isabel	Electrical Engineering	Mexican	Arizona
Adriana	Industrial Engineering	Mexican	Arizona
Yolanda	Industrial Engineering	Peruvian	Arizona
Salma	Mechanical Engineering	Mexican	Arizona

### **Data Collection and Management**

Approaching the research questions from a constructivist framework led to hermeneutical and dialectical methodologies (Guba & Lincoln, 1994). Because the researcher was looking to understand and reconstruct the experiences of Latina students who pursue an undergraduate education in engineering, the most effective way to obtain and refine data was to observe the interaction of Latina students within the engineering culture they built amongst themselves and through a mutual dialog with participants. Therefore, data for the study consisted of the researcher’s field notes from observations of the cultural student organization’s



executive board meetings and transcriptions from a series of individual interviews with Latina engineering students. A combination of data collection methods was necessary, because it is not uncommon for people to *say they do* one thing, but *do* something else (Corbin & Strauss, 2008). Therefore, the pairing of observations and interviews provided the researcher with a more accurate and holistic understanding of the culture and experiences of Latina students in engineering by providing multiple methods and data sources through which to triangulate (Mathison, 1988). Interviews allowed participants to describe their background and experiences in their own words, while observations allowed the researcher to discover cultural nuances of which the participants may not have been consciously aware of or subtleties of interactions that participants may not have been able to articulate (Corbin & Strauss, 2008).

Throughout the course of the study, the researcher observed one four-hour planning session and five two-hour executive board meetings. At each observation, the researcher took field notes of her observations during the meetings and summarized and synthesized her observations after the meetings. Following the example of Miles and Huberman (1984), she recorded a summary of the meeting's purpose and agenda items, her perceived explanations and speculations about the culture of the organization, unexpected occurrences that happened during the meeting, how findings from the current observation would affect the next steps for data collection, and implications of any findings for coding and analysis. The researcher's field notes and summaries were stored in a locked drawer in her office for security.

In addition to the observations, interviews were necessary because a researcher cannot observe what others feel or think, nor can she observe events that occurred in the past (Merriam, 1997; Patton, 2002). Ethnographic interviews are one-on-one interviews that are framed within a larger context of observation. This interview method allowed participants to describe the culture and environment surrounding the phenomenon from their own experiences and in their own words as the researcher was able to contextualize the data through her own observations. Interpretive interactionism calls the researcher to listen to and record the stories of the participants and then build upon those stories with creative and active interviewing (Denzin, 2001). Individual interviews were an opportunity for the researcher to acquire a holistic understanding of the participants' experiences within the larger Hispanic culture and the culture of engineering.

In phase one, the researcher utilized a semi-structured interview protocol (see Appendix H) to interview two students. The first phase of research served as a pilot study in which the researcher practiced her skills as an interviewer by assessing the value of each interview question toward the proposed outcomes and ensured the sensitivity of the protocol to the ethnicity and gender of the population. Data collected from these interviews was then used to adapt the protocol for the second phase of research.

In phase two, data were collected through observations and two individual interviews with each of the seven participants. Spradley (1979) contends:

It is best to think of ethnographic interviews as a series of friendly conversations into which the researcher slowly introduces new elements to assist informants to respond as informants. Exclusive use of these new *ethnographic elements*, or introducing them too quickly, will make interviews become more like a formal interrogation. (p. 58)

Following this perspective, it was important to collect data through more than one interview to allow the researcher to gradually build her rapport with participants, to introduce new topics at a pace that was consistent with the level of trust between the researcher and participant, and to avoid time constraints that could have inhibited the thorough exploration of each topic.

A protocol was necessary to ensure that the research questions were addressed during the interviews and that all participants were asked the same questions to elicit reliable responses (Kvale, 1996). Additionally, a protocol allowed the researcher to limit her voice during the interview by guiding the participant to address specific topics and using follow-up prompts to elicit further detail and explanation from the participants. Consistent with a constructivist approach, the interview questions were “broad and general so that the participants [could] construct the meaning of the situation, typically forged in discussions or interactions with other persons” (Creswell, 2009, p. 8). Flexibility within the protocol allowed the researcher to more deeply explore any unexpected responses that arose during the dialogical interview. The open-ended nature of the questions gave participants a strong voice in the research process, as the subjective meaning of their experiences were self-constructed within their own social and historical context.

To develop the interview protocols, the researcher employed the practice of *bricolage*. Lincoln (2000) describes this as “the practice of bringing together, typically in a methods sense, whatever appears to work best in a given context, and with a given group of research participants” (p. 245). Since little research has been conducted specifically on Latina persistence in engineering, it was necessary to piece together influences from studies that explored gender issues in engineering, the retention of ethnic minorities in higher education, and other persistence literature. Therefore, the researcher developed her interview protocols with influences from Margolis and Fisher (2003) and Vasquez (2007), who studied the persistence of women in computer science and the persistence Latinos in engineering, respectively. Additionally, the researcher referenced Eccles et al.’s (1983) Expectancy Value Model of Achievement-Related Choices when adapting and designing interview questions that addressed the research questions.

In the second phase of research, the researcher’s primary aim of the first interview was to build a level of trust with the participants by asking them to describe their identity, background, family structure, value system, and why they chose to pursue a degree in engineering. After developing a better sense of the participants’ backgrounds, the second interview focused on the participants’ achievements and successes to determine the characteristics that have made them successful engineering students, the support systems that helped sustain them along the way, and how these experiences helped them to prepare them for a career in engineering. The questions specifically explored the challenges they faced in the curriculum, the interactions they had with other students and faculty,

and their involvement in extracurricular activities. Both interviews utilized questions honed in the first phase of the study and new questions that were developed to elicit a “thick description” of the participants’ experiences (see Appendix I) (Geertz, 1973). After each interview, the researcher gave each participant a copy of their interview transcription to check the accuracy of data collected in the interview and to theorize initial findings in an effort to fulfill reciprocity with participants (Lather, 1986). In the end, the goal of a constructionist methodology is to clarify a construction that is more thorough than any other construction of the phenomenon (Guba & Lincoln, 1994). Full reciprocity, multiple interactions with the participants, and triangulation of the findings through multiple data sources and collection methods ensured that the researcher was able to refine the data to develop the most thorough understanding of undergraduate Latina persistence in Engineering at ASU to date.

Interviews were held at a mutually agreed upon time in a location that was most convenient and comfortable for the student. Participants were asked to select an interview location, but were made aware that a private setting free from background noise was optimal. For both interviews, the researcher offered her office, an unused office near the engineering student center, or any other location as potential options. Six of the seven participants chose the unused office for both interviews, and the seventh participant elected to meet in the researcher’s office for the first interview and the unused office for the second interview. The unused office was a location convenient for students traveling between classes and helped

minimize the power dynamic by meeting in a location that was more neutral to both parties than the researcher's office.

The researcher hired a professional service to transcribe audio recordings of the interviews and the researcher checked each transcription for accuracy. Given the researcher's lack of practice transcribing, it was more effective and efficient for her to review a professionally transcribed document to ensure accuracy and to insert observations from her interview logs than to inefficiently use her time to complete the transcription process. Using a professional service with a quick production time allowed her to review the transcriptions within days of each interview to ensure the details of the interview were fresh in her mind. Kvale (1996) states that "once the interview transcriptions are made, they tend to be regarded as *the* solid empirical data in the interview project" (p. 163). Therefore, it was important to ensure that the transcriptions accurately reflected the interviews and were processed according to a timeline that allowed the researcher to analyze the data prior to conducting subsequent interviews.

### **Data Analysis**

Throughout and following the process of data collection, the researcher analyzed her field notes and interview transcriptions to identify themes among participant responses and occurrences at the student organization executive board meetings. Consistent with the ideals of qualitative research, the researcher used a "constant comparative method" (Glaser & Strauss, 1967, p. 220) of analyzing data during and after collection. Employing this method throughout data collection was important for the researcher to compare new findings with data previously

collected to identify similarities, differences, and areas that needed further investigation. The two-phase format of this study enabled the researcher to collect data in a pilot study, analyze the data collected, and adapt her methods for the second phase. Similarly, analyzing the data collected after each interview in the second phase permitted the researcher to alter the interview protocol and style prior to the second interview with each participant. For example, after reviewing transcriptions from the first round of interviews, the researcher was able to identify times that she interrupted her participants and was consciously able to be a better listener in the second interview. Similarly, the researcher became more familiar with the speaking styles of each participant after reviewing transcriptions from the first round of interviews, so she was better prepared to provide time for some participants to think about their answers and to ask more intrusive follow-up questions with participants who provided vague answers. The researcher was also able to ask questions in the interviews that were inspired by the data collected in the first interviews or by themes that emerged after constant analysis of the observation data.

Corbin and Strauss (2008) present a variety of analytic tools that the researcher implemented to help facilitate her analysis. These tools helped to avoid approaching data from a conventional way of thinking, framing the phenomena through the researcher's personal experiences or assumptions, or rushing through valuable data that would otherwise be overlooked. Throughout analysis, the researcher most frequently employed questioning and making comparisons (Corbin & Strauss, 2008). First, the researcher compared the data

collected across participant stories and compared her data from the interviews and observations to findings in the literature, both of which led her to ask herself questions that guided further data collection and analysis. When the study data differed from previous research, the researcher questioned the nature of the differences, to what the differences could be attributed, and why the differences occurred. Similarly, the researcher compared the data collected in each participant's interviews and asked questions regarding differences or similarities among the experiences of each student. For instance, the researcher noticed that students self-selected teams for class projects differently—some worked with all female teams and others with all Hispanic teams. By comparing participant stories, the researcher was able to ask questions that gave valuable insight into how participants' gender and ethnic identities affected their ability to work with other students.

As the researcher used these tools to guide her data collection and analysis, she regularly wrote memos and drew diagrams to track her progress. Corbin and Strauss (2008) assert that “without memos and diagrams there is no accurate way of keeping track of cumulative and complex ideas that evolve as the research progresses” (p. 140). Memos allowed the researcher to keep a comprehensive diary of data exploration, synthesize the data using both the participant's and researcher's words, and develop the attributes of concepts and categories that were used later for coding. Additionally, diagrams helped the researcher identify key ideas from her data collection and to better understand the interconnectivity of the concepts that emerged from the data.



The researcher used *HyperRESEARCH* qualitative data analysis software to review the raw text, record her memos and diagrams, and code the data. “Coding is the process of organizing the material into chunks or segments or text before bringing meaning to information” (Rossman & Rallis, 1998, p. 171, as cited in Creswell, 2009). The researcher reviewed each transcription to select and label text relevant to the research questions, identified repeating ideas among the relevant text, and categorized the repeating ideas into concepts and categories. Categories (also referred to as themes) are “[h]igher-level concepts under which analysts group lower-level concepts” (Corbin & Strauss, 2008, p. 159). Throughout the coding process, the researcher used open coding and axial coding. Open coding refers to the breaking apart of data to delineate different concepts, while axial coding describes the process of relating concepts to each other (Corbin & Strauss, 2008). Through the use of open coding, the researcher was able to approach the data with fresh eyes and develop innovative concepts based solely on the transcription data. Reanalyzing the data using the lens of axial coding then enabled the researcher to identify relationships among the data that were consistent with the ideas of goals, perceptions, and motivations outlined in Eccles et al.’s (1983) Expectancy Value Model of Achievement-Related Choices.

The researcher took steps throughout the data collection and analysis to ensure that the data was both reliable and valid. “Reliability pertains to the consistency of the research findings” (Kvale, 1996, p. 235). The researcher personally conducted all interviews using a predetermined, semi-structured protocol. Although follow-up prompts used during the interviews varied based on

participant answers, all interviews were guided by the same question set to ensure that each participant had the same opportunity to relay her story. The same professional company transcribed audio recordings from all of the interviews, and the researcher reviewed each individual transcript to guarantee accuracy and uniformity of detail. Furthermore, the researcher personally analyzed and coded all transcripts for consistency.

Given the researcher's use of a constructivist lens, she used direct quotations from the participants whenever possible in the presentation of data. Corbin and Strauss (2008) reference one reason for the importance of this practice:

Researchers are translators of the other persons' words and actions. Researchers are the go-betweens for the participants and the audiences that they want to reach. As every language translator knows, it is not easy to convey meaning. Words can have different meanings from one language to another and from one situation to another. (p. 49)

Therefore, it was imperative for the researcher to ask clarifying questions throughout the interviews and later use the respondents' exact words as they were the most accurate description and interpretation of the research phenomenon. Moreover, interpretive interactionism "can help researchers to identify different definitions of the problem and the program being evaluated" (Denzin, 2001, p. 2). Therefore, the researcher shared preliminary findings with the interview and observation participants in order to negotiate the meaning of these findings, solicit disconfirming evidence, and fill any gaps in the data (Denzin, 2001; Lather, 1986).

The primary intent of collecting and analyzing the data was to maintain successful activities and improve support services offered within the researcher's direct community of practice in the Ira A. Fulton Schools of Engineering at Arizona State University. As noted in the description, the efforts of the Engineering at ASU services varied in methods and target audience. Some activities focused on what Rosser (2004) referred to as "solutions for the individual" (p. xxii). These interventions concentrated on individual scientists and engineers by offering personalized professional development agendas, one-on-one mentoring in the industry, and grants focused on the career development of a single researcher. Conversely, one may argue that providing exclusive support for a targeted population indicates an inability for success among that population. For example, "the female-focused intervention model implies the inadequacy of women, an implication that is at odds with their retention and success" (Battles, 2009, p. 6). With the collected data, the researcher sought to identify the strengths and weaknesses of implementing solutions for the individual and blanket programming. After completing the data collection and analysis, the researcher identified key themes and best practices of persistence efforts to improve existing programs and develop new activities that will boost the retention and graduation rates of Latina students in Engineering at ASU.

## CHAPTER 4

### FINDINGS

Throughout the interview process, participants revealed the characteristics they possessed that helped them persist in engineering and discussed the experiences that affected their continued enrollment in engineering. Through careful analysis of each student's story, three core motivators emerged from the interview data that led to their engineering persistence: well-defined expectations for educational success of the participants by their parents; participants' perseverance through discrimination and drive to disprove non-believers; and participants' desires to serve as role models and expand the engineering opportunities of others. Chapter Four provides detailed descriptions of each of these motivational themes, as described by the students.

#### **Familial Expectations for Success**

Participants consistently referenced their roles as daughters, sisters, granddaughters, and family women. The familial ties of all participants and the roles of their families in motivating and shaping their engineering identity became increasingly apparent throughout the course of each interview. In fact, three of the seven women listed a family role among their descriptors in the "I am" activity, an exercise in which each participant was given 60 seconds at the beginning of the first interview to write a list of self-descriptors to finish the sentence, "I am \_\_\_\_." Tatum (1997) recommends using this exercise to identify the parts of our identity that capture our attention first. In the "I am" exercise, Adriana described herself as a good sister; Salma identified as a

daughter, a sister, and an aunt; and Yolanda distinguished herself as a daughter and wife.

All of the participants lived with one or both parents for the majority of their childhoods. Although grandparents, aunts, uncles, and siblings were often present and had a strong supporting role in the participants' childhoods, their parents were most instrumental in guiding the participants' paths by establishing an extensive set of expectations. These expectations were a key motivator in the participants' initial decisions to pursue a degree in engineering and later played a role in their persistence in the field. This section will detail how the participants' parents defined success through their educational achievement, depict the parents' rationale for their expectations, explain parental expectations for financial success through educational success, and illustrate how these parental expectations affected the participants' decision making processes surrounding their choices to major and persist in engineering.

### **Success Through Education**

Early in the participants' childhoods and continuing through their college careers, many participants sensed their parents' expectations to be successful. For each student, the measure of success was different. In some cases, students were expected to earn "A" grades. In other situations, students were expected to give their full effort toward their endeavors. Still other students were expected to utilize the knowledge they gained in the classroom beyond the walls of their educational institution. In all of these cases, success revolved around the

participants' performance in school and equated to investing their greatest effort in academic undertakings and doing well in their classes.

According to Salma, academics were the highest priority in her household. "My parents always stressed education when we were young. That was always the main focus growing up: do well in school." She explained that her parents established their expectations early by enrolling her in Head Start, a childhood development program for low-income families. Later, Salma's parents chose not to send her sister to the local junior high because of the poor academics and presence of "troublemakers," so her parents enrolled both girls in a charter school that they hoped would provide a better quality education for their daughters. Salma's parents also used her teachers as a conduit to reward her academic achievements.

I remember my parents they would—we didn't know it at the time, but after every school year they would give us trophies at the end of the year. They didn't give it to us directly, they were given to the teachers, and the teachers would give them to us while we were in class. We thought we were so cool and special because we got trophies.

Salma's parents consistently sought the best educational opportunities, had high expectations of her to perform well in her classes, and rewarded her academic accomplishments. Salma later described her parents' expectations for college: "They never said, 'You have to go to college,' but they never—there was never a question. They were encouraging me to go to school and to do well." Because of these expectations, Salma consistently performed well in school and has remained dedicated to her studies, as not to fall short of her parents' expectations and to

take full advantage of the opportunities for which her parents worked so hard to provide.

Yolanda's parents also had lofty expectations for her academics. While living in Peru until age 11, she attended a private school where she received a strong educational background. Though her father regularly helped with her math homework, Yolanda's dedication and work ethic extended into other subjects and quickly became a way of life for her. "They definitely always have pushed me to do better...I just kinda developed that, that want to be—to do good in school...They really kinda embedded that in me." Because Yolanda's parents clearly defined the importance of education early in her childhood, she carried the expectation "to do good in school" throughout high school and college in the United States. Although her parents rarely supervised her studies later in her academic career, Yolanda remained motivated to earn good grades and to complete her degree in engineering so that she could exceed the educational expectations that her parents instilled in her throughout her childhood.

Adriana also described how her parents' expectations of her became a guide in her educational life. "I think my parents always pushed me to be good or expected it. That's the word, *expected* me to do good always, always, always...Now by myself, I expect myself to do good and to be good." These ideas of "doing good" and "being good" extended beyond academics and were developed in the private school that Adriana attended. She described her school as "one of the best ones" for education in Mexico and also "for teaching you values—how to be a good person and all the ethical aspects of it." For Adriana,

the academic expectations of her parents exceeded a strong content-based performance in the classroom and extended into using the skills and knowledge that she learned to improve society.

For many of the participants, their parents' expectations for success were expressed through their educational endeavors. Whether students were told to "do well in school," "do good in school," or "to do good and to be good," their parents' messages was clear: education was important and they expected high academic achievement. Though the participants' parents expressed their expectations early in the participants' childhoods, in most cases their parents' academic expectations went unsaid after elementary school. However, these expectations continued to motivate the students to pursue a postsecondary education after high school and to persist toward degree completion in the academically rigorous field of engineering.

### **Rationale for Educational Expectations**

These expectations for students to become academically successful stemmed from one of three core justifications. First, parents viewed education as the means through which their daughters could gain access to future opportunities for success. Second, parents wanted to provide their daughters with opportunities that were not available to them when they were growing up. Finally, parents aspired for their daughters to be successful in areas in which they were not able to succeed themselves. In some cases, a combination of these rationales helped form the parents' expectations.



Adriana's parents placed importance on her academic performance because they viewed school as a means that could open doors and provide opportunities in the future.

My dad has always—he says that if one thing he'll make sure that we have is education. He'll do anything to pay for it, or to help us with it, and to have it. Because he thinks that's what we'll—that's what our future depends on.

Adriana's father believed her choices before and during college would affect her future ability to find a job, support herself, and be happy, so he encouraged her to attend a university in the United States because there were more opportunities for employment in engineering in the U.S. than in Mexico after earning her degree.

Though Adriana's parents made their intentions very clear, other participants' parents were less forthcoming about the reason for their expectations. At one point, Salma reflected on why her parents placed such an importance on academics.

I think part of it might have been the way they grew up, and they didn't have very many opportunities in Mexico. Maybe when they came here and they had us, they wanted us to take advantage of the opportunities that were here.

Salma noted that her mother earned her General Educational Development (commonly referred to as the GED) diploma after moving to the United States in the early 1980s, and both of her parents worked a variety of jobs before they were able to establish their own cleaning business. As she referenced, Salma's parents moved to the U.S. to find more opportunities for success, and her parents consistently enrolled her in a variety of educational support systems, seeking the best resources available for their daughters.

Unlike Salma, Rosa grew up in an environment where education was an opportunity not afforded to women. The women in her family were factory workers, field workers, or stay-at-home mothers. Rosa's mother completed only a first-grade education before Rosa's grandfather pulled her from school. As a result, Rosa's mother never relayed any academic expectations directly to her, and was overtly unsupportive of her educational endeavors, often telling Rosa, "You're gonna get pregnant. You're gonna drop out of high school." However, Rosa later learned of her mother's decision that enabled her children to partake in an educational experience that she never received.

When I was younger and my dad left us cause he was in jail, she had the opportunity to go back to Mexico and be taken care of by my grandpa, and she said, "No, my kids need to go to school."

Because Rosa's grandfather removed her mother from school after the first grade, Rosa's mother was concerned that her children would also be removed from school if they moved to Mexico to live with Rosa's grandparents. Consequently, Rosa's family struggled for many years, as her mother was a single parent and sole provider for several years of Rosa's childhood. However, Rosa's mother made this choice because she recognized the importance of educating Rosa and her siblings. Although her mother never believed in the possibility of the educational success that Rosa achieved, her mother's choice provided Rosa and her siblings with educational opportunities, career choices, and financial resources that their mother never received.

In other situations, the participants' parents were given educational opportunities, but were unable to reach the expectations set by their own parents.

Consequently, the participants' parents pushed their daughters to succeed in the same areas in which they were unable to be successful. For example, the expectations of Gabriela's grandmother influenced the standards that were passed down to her through her father.

My grandmother was very, "You will get an education, you will do good, if you don't, you are not leaving this house until you do." My dad kind of put that emphasis on me, that's why he went to college. With the whole family-supporting thing, he couldn't do it. My dad's like, "You will graduate high school, and you will graduate with a high GPA. You will get 'A's.'"...Of course, I'm expected to graduate college, and I will be the first to do so.

Because Gabriela's father spent only two years in an electrical engineering degree program before dropping out to support his family, Gabriela felt even more motivated to persist in her engineering degree program. The pressure to succeed in an area in which her father had not succeeded weighed heavily with Gabriela and was an integral motivator throughout her career as an undergraduate student.

### **Financial Benefits of Educational Success**

Many parents saw education as a means for their daughters to achieve financial stability. Gabriela described her father's expectations as, "He just wanted me to be successful—make enough money so that I didn't have to work several jobs to pay off bills. He's like, 'make enough money so you could live comfortably.'" While Gabriela's parents wanted her to be financially independent to alleviate any unnecessary economic burden, Gabriela perceived the need for economic security to have significant long-term implications on her ability to repay the debt to her family.

Then, of course, the whole thing is that you always take care of your parents afterwards. Right now they're helping me pay through college. Of course, all the money that they spent as I was growing up. Now it's like, as soon as I get a job, I'm expected that I start paying them back in some form or another.

Gabriela explained the pattern in her family, as her grandmother's three sons each cared for her grandmother in a different way: one takes her on trips, another provided her with a house, and the third cares for her everyday needs because he lives the closest. The expectation to provide her parents with "a little add-on house" on the property of her future home and to sustain a higher standard of living was a constant motivator for Gabriela to continue her studies in engineering. She recognized that a degree in engineering would equip her with the skills necessary to secure a career that could support this profitable lifestyle.

Similarly, the need for financial stability and the ability to take care of her parents also played an important role in Salma's initial decision to major in engineering.

I wasn't like oh, I'm out to make a lot of money and stuff. It was more like, you can live comfortably and not have to worry. Also I would like to, in the future, just be able to provide for my parents too. They're not going to be working forever.

Like Salma, few participants enrolled in engineering to become rich. Instead, they understood that a degree in engineering would afford them a comfortable lifestyle in which they could provide for their parents, which was often referenced as the norm in Hispanic culture. This expectation that Salma and the other participants would financially care for their parents motivated the participants to not only enroll in engineering, but also to persist.

## **When Expectations Conflict with Desires**

While each of these students faced the pressures of their parents' expectations to be successful, to perform academically, and to become financially stable, the students also faced difficult decisions when the expectations of their parents conflicted with their cultural expectations or when the expectations of their parents conflicted with their own dreams and goals. In some cases, the participants' career paths aligned with the visions of their parents, and their parents' expectations reinforced their choices throughout college. In other cases, the students' ambitions may not have entirely fulfilled their parents' expectations, and they were forced to weigh their own desires against the wills of their parents.

In both interviews, Salma admitted the countless times she wanted to drop out of engineering. She was the only participant to change her major within engineering and she was the least sure of all participants about her future career in engineering. Referring to her initial major of bioengineering, "the career paths they were emphasizing just weren't that interesting to me." She discussed the numerous art classes she took in high school and recounted how, "I always thought I'd go down that field [of art] or maybe architecture or something." However, her parents encouraged her to pursue the field of engineering. Once enrolled, their expectations of her persistence in engineering continued. "If I ever mentioned switching my major, my mom was like, 'No, no, no.' She wouldn't have it." The voice of her mother and the obligation she felt to her parents served as a motivator to persist whenever she considered leaving engineering:

Every time I thought about I wanna switch out [to a different major], part of the thing that kept me in engineering was the fact that my parents were really proud to have—for me to be in engineering. I think they might see it as a waste. And other people might see it as a waste of like, “Oh, you’re so smart, and you don’t want to be in engineering?”

In addition to living up to her parents’ pride in her accomplishments, Salma also faced a pressure not to “waste” her talents or potential. Because this opportunity to pursue a difficult field like engineering was not a viable option for many of her Latina friends and family, Salma disregarded her self-doubts about her fit in engineering and was motivated to continue towards her bachelor’s degree in engineering so that she could fulfill the expectations of her parents, fully utilize her talents and intellect in a rigorous field, and represent her gender and culture with pride.

For Paloma, the differences between the expressed expectations of her parents and the expectations of her culture caused an internal struggle when deciding which career path to pursue. Paloma grew up dancing, and it remained an important part of her life throughout high school. Her parents were supportive of her interests and financed dance classes at a local studio. However, her love of dance was tested as she narrowed her choice of major to prepare for a career as a dance teacher or as an engineer. On one hand, her parents were very accepting and supporting of her passion for dance, placing more emphasis on her happiness than her financial longevity:

They were always, even my dad, was always really open. “Oh, whatever you want. If you wanna do the dance teacher or whatever, just do whatever makes you happy.” They weren’t really pushy about, “Oh, are you gonna go to college? How are you gonna pay for it?” They were like,

“Oh, you can do whatever you want. If you wanna go, if you don’t wanna go, it’s fine.” As long as I did something above high school.

Paloma knew that her parents expected her to go to college and do “something above high school,” but the decision she faced in choosing a major forced her to weigh the long-term feasibility of her interests against the cultural expectations of the Latino community to provide for her family.

Then I was like oh well, I do wanna do the dance thing, but I’m not gonna be able to help my parents with it in the future. ‘Cause I’m—so as Hispanics, we take care of our parents once we’re older. Since I’m the oldest, I all of a sudden, well, all my life I always took the responsibility, and I always knew that I was gonna—I know that once they’re older I’m gonna take care of them. I’m gonna have that responsibility, plus my family. So I was like, well, I should do something then with—and since I like that kind of math—do something with math.

While this expectation to care for her parents guided her decision to major in engineering, she did not abandon dance completely. Paloma decided to make a practical and culturally-sound choice for her major and a personal choice for her minor.

Then I started thinking about oh well, how is [dance] going to affect me in the future? How long am I gonna be able to dance? And is that actually going to support me? Do I want to not be able to support myself, or only myself? A lot of questions started rising, so I was like well, for now I’ll just do the minor and do a major in engineering.

At one point, Paloma tried to balance her personal desires and parental expectations by double majoring in engineering and dance, but was unable to complete the required milestones for the dance major. Reflecting on her experiences, Paloma did not believe that she would have been able to handle both of these different fields simultaneously and was thankful that she chose the engineering major, as engineering could afford her a more sustainable career.

However, she also fulfilled her personal goals by completing the requirements necessary to earn a minor in dance.

Not only did the expectation to care for parents affect the participants' initial decisions to pursue engineering and their choices to persist in engineering, but it also had implications on whether they pursued graduate studies or entered the engineering industry immediately after graduation. For example, Rosa discussed her conflicting desires and obligations.

I wanna go to industry, but at the same time I really do want to get a Ph.D. I feel kind of selfish a little bit, because I know that my family is struggling a lot now, so if I go to Ph.D. that's five more years that I can't help them with money. But, I could just work now and help them now. But, I could help them more when I have a Ph.D. later. But it's kind of something that, I guess I don't know if it's just for every Hispanic. Mostly I guess it is a culture thing that you always have this need to help your family, which is kind of like breaking me a little bit. I'm trying to make my decision. Where do I wanna go?

Even without a strong support system, Rosa's concerns for her family continued to influence her everyday choices and the future of her career path.

I guess that's one of the—one of something very important for me is my family, to make sure that they're doing okay, so that's always been in the back of my head when I make a decision is my family.

Rosa's obligation to provide for her parents and her siblings was a motivating factor for her success and progress toward degree achievement in engineering, but this expectation also provided a struggle. She constantly questioned and compared the best choice for her family, the best choice for herself, the choice that provided the best immediate payoff, and the choice that provided the best long-term payoff. With all of these implications, Rosa did her best to make decisions that best balanced the needs of both her and her family. Though her



parents were often unable to see her wisdom at the time of the decision, Rosa worked to show her parents the payoffs of her decisions so that they would learn to trust her instincts and be more supportive of her younger siblings' abilities to make their own decisions.

### **Familial Expectations Conclusion**

Given the stories of these participants, parental expectations played an important role in their decision-making and their choices to pursue a bachelor's degree in engineering. Parental expectations to be successful, become high achieving students, become financially independent, and care for their parents weighed heavily with these Latinas. In some situations, these expectations clashed or diverged from their own goals. However, these expectations served as a central motivator in the participants' decision to pursue engineering and later to persist in the field.

### **Overcoming Discrimination, Stereotypes, and Non-Believers**

Given the participants' persistence in engineering, it is easy to assume that they did not have the same challenges as students who withdrew from their engineering major. However, nearly every participant faced discrimination from faculty, were stereotyped by their peers, or encountered others who did not believe in their ability to be successful. Despite these negative experiences, participants were proud of their accomplishments, excited to accept the challenges of representing their gender and culture as the minority in engineering, and motivated to disprove the non-believers and to contribute their unique perspective to the field of engineering. This section will recount the different barriers faced

by participants, describe the students' strategies for overcoming these obstacles, and illustrate how these experiences motivated the students to persist in engineering.

Many participants referenced their determination and hard work as keys for their persistence in engineering. In the "I am" exercise, Isabel and Paloma listed *determined*, while Adriana, Gabriela, and Rosa all identified as a *hard worker*. Isabel expanded on the importance of these characteristics for succeeding in a difficult industry. "Like I said, I'm very determined. Whether I have fallbacks or not, I always keep my goals straight. Even if there's obstacles in the way, I don't let that get to me." This resolve and perseverance emerged as a crucial characteristic of the women's motivation to overcome the gender- and culture-based barriers that they faced as engineering students.

### **Barriers to Success**

Five of the seven participants cited at least one example as an engineering student where they encountered an instructor who did not treat them as an equal to the male students in the class or a situation where their male peers stereotyped their contributions to the course because of their gender. In one example, Rosa's instructor publically disaffirmed her answers in classroom discussions, while consistently affirming the participation of male students. Rosa described how many female students withdrew, but she endured the unfair treatment of the instructor teaching a required first-year class:

My least favorite class was my freshman year—it was [calculus]. I had a new professor...He was very sexist. Very sexist. We had this class, there were five girls and they all dropped out, except for me and somebody else.

He was really mean to me... If I ever raised my hand and I answered something correctly, he would be like, "You over-simplified." Some other times, I didn't simplify enough. Anything I did was never what he wanted. If anybody else answered, he would be like, "Good job, Josh. Good job, Mark." But if I answered he wouldn't like—he would not really say anything nice to me.

While the effect of an experience like this varies from student to student, Rosa was deeply distressed by the actions of her instructor.

That semester was very upsetting. That was my first semester here and I was really upset, because math was my favorite subject. It was my passion, and he just completely ruined my entire freshman year experience just by doing that.

Though Rosa encountered trouble with only this one professor, the experience had a broader impact, which led her to question her skill level and choice of major.

Isabel had a similarly disappointing experience in which she stood out as one of only two females in a class with more than 40 male students. This limited female enrollment caused her to be singled-out by the professor when grading an exam.

We had our first quiz and the material that was on it was not even relevant to what we learned, so I put on the back and wrote him a note...I get my test back, or my quiz, and he gave me my grade point of what I deserved, and then he took off 15%. He wrote a note. He was like, "Well, maybe if you came into class you would know more."

Isabel went on to explain that although the instructor did not take attendance in the class, he had confused her for the only other female student enrolled, who attended the class with less regularity.

In addition to the gender-based discrimination that participants encountered with faculty members, the women also described how male students stereotyped their roles and contributions to group activities. Paloma explained

that when she joined a team with four male students in one of her engineering classes, she was assigned a role different than that of the men in her group.

The three older guys were like, “Oh, we’ll do the hard stuff, blah, blah, blah” and they would give me a small portion, and then the other guy a bigger portion than me. So there’s always like that thing about like “Oh don’t worry, you’ll be the secretary.”

This responsibility of serving as the “secretary” demeaned Paloma’s role in the team by implying that female students are not mentally or physically capable of the difficult engineering concepts involved with the project.

In addition to the secretary stereotype, other participants experienced a similar, but different, stereotype of women in a position to mother their male teammates by tracking assignments and deadlines for them. For Salma, her role as the lone female in a group evoked anxiety as she was asked to not only manage due dates, but was also looked to by her male peers for guidance.

At least my friends, they think I’m so smart. I don’t know if it’s because I’m a girl in engineering or they just have this expectation that I’ll always have the right answer or I’ll know what to do. I don’t know if I like that pressure.

She later explained that her male friends in engineering classes depended on her to remind them of homework assignments and deadlines. “I’m the one that always has to stay on top of things, because if not, we’re all in trouble.” This pressure to take care of her friends and to fulfill the higher expectations of a woman in engineering weighed heavily in her relationships with male peers.

Outside of the classroom, many participants also faced non-believers, or those who overtly expressed disbelief in the participants’ abilities to succeed or earn a degree in engineering. Isabel’s academic advisor served as the non-

believer most influential in her academic journey. After failing her circuits course, a class that affected her ability to complete a required set of sequential courses, Isabel developed a plan that would allow her to shift some courses in her degree flowchart, retake the class she failed, and get back on track over the summer without falling a semester behind. Despite outlining her detailed plan on paper, her advisor failed to support her strategy. While her advisor may have referenced her inability to get “on-track” according to the advising milestones established by the university, Isabel interpreted her advisor’s disbelief in her plan as a lack of confidence in her cognitive ability to successfully pass the required classes.

Beyond the campus, students like Rosa also faced discouraging comments from family members and friends in the community. “For people outside of my family, like for my dad’s friends, when they found out I was going to college, they’re like, ‘Oh, I didn’t think Mexicans went to college.’” Hearing these cultural norms and the gloomy expectations of the low-income Latino community in which she grew up served as a constant reminder for Rosa that she would need to work even harder to succeed in college and that she had dismal odds for successfully earning a degree in engineering.

### **Strategies for Success**

Although the discrimination, stereotypes, and non-believers often faced by women in engineering can carry a burden that leads them to withdraw from the field, the participants in this study used these experiences as motivators to persist. The women who faced discriminating professors sought to enroll in future

engineering classes in which professors affirmed their knowledge and supported their skill development. The participants worked to exceed the expectations of their male teammates and to demonstrate their capabilities in engineering. And the students who faced non-believers worked even harder to “beat the odds” and prove the non-believers wrong. To do this, the women employed a set of strategies that included speaking up for oneself; proactively establishing their credibility within a team; actively focusing on being less sensitive; and developing goals to disprove the non-believers.

In both cases where participants faced unequal grading, the students approached their professors to stand up for themselves and discuss the problems with their grading. Rosa described how she confronted the instructor to inquire about the ‘A-’ grade that she received, instead of the ‘A+’ she felt that she earned. “He eventually did switch it to an ‘A.’ I thought I deserved the ‘A+,’ but I just didn’t push it because I was afraid of him.” Although the outcome was not ideal for Rosa, her ability to handle the situation and negotiate with the professor reaffirmed her ability to endure any future challenges in engineering and motivated her to continue in a field where she knowingly could face other discriminating faculty members.

In Isabel’s case, she approached the professor to discuss his note on the back of her quiz. Once they determined that she did not wear glasses and was, in fact, not the other female student in the class, he awarded the points back to her and gave her additional points. It was unclear whether these points were to address the discrepancy of concepts taught versus those tested, or whether the

points were an attempt to compensate for the identity confusion; however, the additional points did not satisfy Isabel. She boldly informed the professor of his flawed approach for grading and attendance:

I was like, “I know about five guys that don’t go to class, so if you’re going to be taking attendance I think you should be fair and put out a sheet so we can sign.” Obviously, everyone is going to notice that the two girls are gone. Are they going to notice that a guy is gone? No.

Although the professor’s method of recording attendance did not change in her class, Isabel felt that she had successfully brought attention to the discrimination, made herself identifiable to the instructor, and was confident that she would be able to address any similar situation that could occur in the future. This confidence further pushed Isabel to continue in her engineering classes and to seek other opportunities where she could prevail as an underestimated female student in her classes.

Isabel was not the only student who noticed the underrepresentation of women in the classroom. Yolanda noted that the number of women in her classes decreased as the material increased in difficulty, using her circuits class as an example.

There’s only like three females I think in that class—or four. I’m pretty sure there’s other females in other classes, but I think that’s a very difficult course...I always work with female teams, and we always were kinda lost...It’s like, I don’t wanna feel that being a female is kind of something that [is] less than a man. It’s just that there’s always that case that makes me wonder that—especially in the hard courses when you don’t see many females.

In these male dominated classrooms, it was not uncommon for the female participants to question their abilities or compare their performance to their male

counterparts. Some of this hesitancy was attributed to the challenges they faced working in small groups with male students. However, Adriana described her strategy for convincing male counterparts of her technical abilities and the value she brought to the team.

Well, classrooms sometimes are—there were like 120 students and there were like five girls in there. All the teams are with guys, and it's just that you think different than men. And sometimes you have to do something to make them understand that you're there and your opinion will be different, but it will still be good and that you can improve in other ways that they maybe didn't think about.

Some students like Adriana accepted this challenge with grace and were successful in convincing their male peers of their aptitude. Other students, like Salma, chose to regulate her sensitivity to her peers' comments and adapt her working style to be successful in collaborating with male students.

You have to learn to be more independent or to work well with guys, I guess. You can't let the things they say bother you. Guys can be kinda harsh or insensitive, you can say. Sometimes we'll be in a group or just talking or hanging out and they'll say some of the meanest things to me. I just have to brush it off because you're working with guys. If you try to be sensitive or whatever, they'll just give you a harder time.

Whether the participants became more independent, less sensitive, or more vocal about expressing their skills, the women were motivated to adjust their habits for continued success in engineering.

In addition to adapting their working style in the classroom, the participants also established new goals to disprove the non-believers whom they encountered. After unsuccessfully convincing her advisor that she would be able to get back in good standing, Isabel was motivated by her advisor's dissent, ignored his disbelief, and followed her own plan to graduate in four years. She



was able to successfully get back on track, and reflected on her ability to succeed in reaching her goals after being confronted with doubt. “Now I look at him, and I’m like, ‘Well, I’m graduating next semester.’” Similarly, Rosa saw the comments of her non-believers as encouragement to disprove their negativity.

It just kind of gives you a little more motivation. Like oh, I don’t have to be that that they want me to be. I wanna do something else, so I’ll just keep doing, even if they don’t think that I can do it. That motivates me more to do it...I want to say like, oh, just because I’m a woman and I’m Mexican, it does not mean I can’t be successful in certain areas.

This determination, hard work, and pride led Rosa and the other participants to use the negative attitudes of those around them as fuel to power their motivation and success in reaching the goal of graduating with a degree in engineering.

### **Discrimination, Stereotypes, and Non-Believers Conclusion**

The strategies exemplified in this section required extra effort for the students, suggesting that it was the sole responsibility of the participants to adapt to the white male-majority environment of engineering. However, these tactics reinforced the confidence of participants; equipped them with a collection of skills that revitalized their self-belief; and further motivated their persistence to overcome other potential discrimination, stereotyping, or non-believers.

Each of the participants in this study consciously invested their full effort in earning a bachelor’s degree in engineering. They were motivated by the discrimination, stereotyping, and non-believers and actively employed resilient strategies of speaking up; establishing their credibility; desensitizing their feelings; and disproving authority to achieve their success in engineering. One participant even acknowledged that success will never be given to her. Rosa

recognized that she must earn every accomplishment, and she may have to put in more effort than her peers for the same victories.

I'll struggle because Spanish—English wasn't my first language so sometimes it'll be a little bit harder for me to understand and so I won't, compared to other of my friends, I won't get it as fast but I'll just work harder. I probably won't get as high grades as them, but at least I understand it eventually. I guess for me it's pride to know that I can do it. I'm like, oh, maybe they thought I couldn't, but I'm doing it now, so it kind of helps me a lot more.

Though each participant struggled against inequity and discrimination in the field, every participant persisted in engineering. Rather than being swayed by the lack of female and Hispanic students or the disparaging interactions with male faculty, staff, and students, these women earned their success through their motivation to overcome obstacles and were proud of their accomplishments.

### **Influencing Others as a Role Model**

Given their success and achievements in engineering, each participant recognized the obstacles that she overcame and was motivated by a desire to minimize the barriers faced by other students. Whether serving as a role model to their younger siblings, improving the opportunities for Latinos and women through STEM outreach, or providing guidance for postsecondary students following in their footsteps, the participants were motivated to earn a degree in engineering, which would allow them to “pay it forward” by providing more STEM opportunities for other Latinas and reducing the barriers that have traditionally inhibited the success of others.

## **Making an Impact**

Participants often referenced their desire to “make an impact.” Adriana explained how she intends to influence those around her:

I want to make an impact in my personal life, in my work life, and also in the community life, so in all three of them. Using my career, what I will use are all those skills that I’ve developed and apply them in those three different fields to make an impact and make progress.

It is important to note that Adriana stated her intention to *use her career* “to make an impact and make progress.” Though Adriana was actively involved in service activities throughout college, she was motivated to earn a bachelor’s and a master’s degree in engineering because she recognized the extended reach her influence could achieve once she completed her degrees. When asked what “making an impact” meant to her, she responded, “Change something or make something noticeable that will help, that will improve, that will do good. That’s what I call an impact.” While Adriana referenced her personal life, work life, and community life as three separate entities, for many participants, the lines blurred. Her personal life provided the inspiration to pursue engineering, her future as an engineer obligated her to give back and broaden the STEM community, and the morals and standards of her family and friends shaped the value of her personal successes.

Looking back on her achievements in college, Yolanda explained how her accomplishments felt like an honor—an honor that she was part of an elite group of strong Hispanic women.

When I’m [in class] I feel like, “Oh look. I’m being part of a small group.” It’s kind of cool. It’s kind of a good feeling to be a woman in

engineering and be a woman engineer. There aren't many—well there are a lot, but not a big portion. I kind of feel good to be part of something that's gonna be—show other younger girls they can be engineers too.

This opportunity to succeed in engineering and to become part of a select group of Latina role models consistently motivated Yolanda to complete her degree.

Similarly, Adriana referenced the satisfaction she earned as a woman in engineering. “I think it's amazing. You go to classrooms, and you're the minority there. I don't feel bad that I'm the minority. I feel proud that I am.”

This gratitude for their opportunities motivated the participants to maximize their “impact” on the lives of others through their achievement of a degree in engineering.

### **Influence on Younger Siblings**

Rosa listed herself as a *role model* on her “I am” exercise, citing the importance for her to be an example to her family. Rosa knew from an early age that she would be able to make a difference in the lives of others, and she was transparent with her intentions when pursuing college opportunities.

I remember that my essays for scholarships and [college] applications started, “I do not believe I can change the world, but I know I can make a difference.” That was my opening sentence. For me, it's just that I became—I wanted to be a role model to myself, but eventually I realized I was even a role model to my parents.

Given her parents' lack of educational success, Rosa recognized that she could not only influence her parents by showing them that it was possible for a Mexican girl to earn a college degree, but she could also serve as a role model for her sisters and brother. With the unsupportive comments of her mother and the absence of her father who spent years in jail, Rosa found it important to

demonstrate everything that her siblings could accomplish with hard work and dedication.

I just wanted [my sisters] to know that there's all these opportunities for them. Growing up I didn't know all of that. I had other people to help me through it...Now my siblings are very excited, and they think that they wanna do engineering as well because I'm always talking about it.

Although Rosa's primary intentions were to entice her siblings with opportunities in engineering, she recognized the importance of education from a broader perspective. "Even if they're not engineering, as long as they go to school, 'cause it became really important to me so I always try to be a role model for them." For Rosa, going to college became a way for her to surround herself with people who supported her passions and to expand the career trajectories that she could pursue. However, she was motivated to do more than simply attend college. It was important for Rosa to earn her degree in engineering, as it would give more credibility to her success story and enable her with more ability to financially support her family and provide trusted advice for her siblings. This idea of creating a college-going culture within her family was a consistent motivator to persist in her degree program.

Similar to Rosa, Isabel was not among the participants whose parents expected her to do well and supported her education. However, she later recognized the importance of this support and chose to play an integral role in her brother's schooling.

In his high school, they have your parents as your main contact and your guardian. I am technically his guardian. I fill out all his papers. Two weeks ago I received a call that he was failing math...Not only that, it's not the only class that he's having difficulty with. The counselor advised

that he goes into tutoring. I told my mom that. Now she's forcing him to go every Monday and Wednesday. I tell him, "It's really important."

This combination of watching both of her older brothers drop out of high school (one later returned to complete his diploma) and facing the academic rigors of college led Isabel to understand the importance of a strong educational foundation. Since her parents still did not see the importance of academics, Isabel was motivated to serve as a role model and to provide her younger brother with the resources necessary for him to successfully enter a skilled career of his choosing. She was motivated to persist in her degree program through her understanding that earning a degree in engineering would enable her to serve as an exemplar for her brother and give validity to the emphasis that she placed on his education.

### **K-12 STEM Education**

For some students, it was important to reach beyond their own family and influence other children and high school students who needed assistance.

Yolanda embraced the opportunity to help students who grew up in a neighborhood similar to hers through the Society of Hispanic Professional Engineers' *Noches de Ciencias* (translated as Science Nights). Yolanda explains:

I think that education's so important for students—especially for high school students. I come from [a] High School [in] Phoenix where a lot of students drop out, and a lot of students don't go to college. I wish I could do more about it. I guess by talking to them at least I can give them the idea or think about going to college. I wish I was more involved, like maybe talk to them more, maybe giving them my number. "Talk to me if you need help or something."

Motivated by her own successes in engineering, she saw these events as an opportunity to reach out and extend the STEM pipeline to students who otherwise may not be reached by the traditional efforts of low-income schools with a large ethnic minority population.

I think it plays a big part because I know that there are not many Latinas in engineering, so I feel like I can become a role model for other younger Latinas. Also, because it's kind of like a challenge because most of Latinos don't go for science either and don't—I don't know why but they don't. I feel like I'm kind of a—part of a small group who can make a change.

This ability to inspire an interest in science and engineering among the children, to educate the students and their parents about the financial resources to attend college, and to explain the long-term benefits of a college education was what inspired Yolanda and the other participants to complete their degrees in engineering and become involved in STEM outreach opportunities.

Similar to Yolanda, Gabriela also became active in outreach with the Society of Hispanic Professional Engineers. She assumed the role of outreach director and was motivated to expand the opportunities of Latinos in STEM.

[I] realized that there are some really terrible schools [in Phoenix]. They need a lot of help, and I feel that if I was given the opportunity to become successful, I should help these kids to get the opportunities to also become successful. Because some of these advisors don't even expect them to go to college, and it's really hard to say we just need you to pass high school and get out of here so we can have another seat open.

Through this experience, Gabriela focused her efforts in one high school for her senior year as the coach of a team competing in the Real World Design Challenge, a national competition that trains high school students to use professional engineering software to solve an engineering challenge currently

faced by the engineering industry. In addition to helping them design a light source aircraft, she brought in professional mentors so the students could talk about college and learn more about the engineering profession. Gabriela excitedly noted that “We even got two of them to apply for college!” and she plans to continue her outreach efforts through graduate school.

Though some participants had not actively participated in K-12 outreach as a student, they hoped to someday offer the same influential resources that initially helped them decide to pursue a degree in engineering. In one example, Isabel referenced the importance of an Intel employee who visited her third grade classroom.

I remember him saying, “When you grow up if you really like this you should become an electrical engineer.” Since then, it stuck to me. I didn’t even know what it was. I honestly didn’t even know until I was probably a junior in high school.

Knowing the influence that this Intel employee had on her educational and career path, Isabel was motivated to persist in engineering so that she could take a similar role in her professional life to shape the career goals of other young students.

I feel like since that third grade incident with Intel coming in, like that’s so nice...They come in, and they’re teaching kids at such little age about technology and stuff like that. I just think it was great, and I feel like that’s something I would be interested in doing: outreach programs.

Isabel’s interaction with an Intel employee in third grade may have influenced her to pursue an electrical engineering education, but her excitement to engage other students in engineering is a key reason that she remained enrolled in engineering.



## **Peer Mentoring in Engineering at ASU**

Beyond their experiences volunteering in the K-12 system, many participants also found value in serving as peer mentors to other college students in engineering. Isabel recognized the importance of having a mentor at the university after signing up for Shades, a multicultural peer mentoring program coordinated by the ASU Graduate College, during her freshman year. Although she was not assigned a mentor until her senior year, she noted that, “it would be nice to have someone that has made it through and would give you hints on how to get there and their secrets.” Reflecting on the guidance that a mentor could have provided for her own college experience, Isabel volunteered as a mentor at E2 Camp and described her rationale for volunteering:

I kind of want to be like that person—like when they ask me, the girls would be like, “So how is it? Is it hard?” I would tell them straight out how it is, what they needed to do, I guess just for advice.

Because Isabel felt that she had faced so many challenges as an engineering student and had to figure out strategies to overcome those obstacles on her own, she was motivated by the opportunity to become a peer mentor to other students by sharing her experiences, offering advice for managing difficulties, and eliminating those barriers for other students. However, she also recognized that to maximize her potential as an engineering mentor, she would need to “make it through” and persist in her degree program.

On the other hand, Rosa served as an informal mentor to her peers by encouraging a fellow Latina engineering student to attend the career fair with her. After Rosa reviewed her resume, provided advice about how to approach

recruiters, and modeled an appropriate introductory pitch, the other student was able to successfully partake in the career fair and secured an interview. “I guess I had never realized I had such an impact on other people. I was the one that made her go. Later on she started calling *me* mentor!” Rosa noted in one interview that she felt successful because of the people with whom she associated herself. One friend encouraged her to become involved in a variety of student organizations, another pushed her to run for an officer position, another arranged an internship opportunity for her, and another persuaded her to apply for a scholarship that she was awarded. With all of this support and encouragement, Rosa was inspired by her peer mentors to persist in engineering and motivated to mentor others in their pursuit of an engineering degree.

### **Role Modeling Conclusion**

While diversified in nature, all of the participants were motivated by the need to give back to their community for the opportunities that they received and to improve the future for other students pursuing a degree in engineering. Some students focused on improving the lives of their siblings to ensure that their siblings received better opportunities than they themselves experienced. Other participants played an active role in the lives of other elementary, high school, and college students to create opportunities, nullify barriers, and expand the STEM pipeline. In any case, their commitment to reaching out to others and caring for the needs of society helped shape the undergraduate experiences of these Latinas and motivated them to persist in engineering.

## **Conclusion**

Through careful analysis of the interview transcriptions and observation field notes, three main themes of motivation emerged from the data. The participants were motivated to fulfill the expectations of their parents “to do well;” to complete levels of academic achievement not previously earned by other family members; and to become financially stable enough to provide for their own family and parents. The participants were also motivated to overcome the discrimination they faced in the classroom; to disprove the stereotypes placed upon them by classmates and staff members; and to invalidate the unsupportive non-believers whom they encountered throughout their educational journey. Finally, the participants were motivated to earn a bachelor’s degree in engineering so that they could: establish a new culture within their family that valued the education of their younger siblings; create a legacy that prepared young girls and children from ethnic minorities for an education and career in the STEM fields; and develop a support system for other disadvantaged students pursuing a bachelor’s degree in engineering. The next chapter will discuss how these findings contribute to the current body of research, how they can be used to improve the programs and services offered by Engineering at ASU, and how they can inform future opportunities for research in related areas.

## CHAPTER 5

### DISCUSSION & CONCLUSION

As outlined in the first chapter, the purpose of this study was to identify the characteristics and experiences of Latina students that affected their persistence in pursuing a bachelor's degree in Engineering at Arizona State University (ASU). In the first chapter, the researcher described the educational landscape in engineering across the United States (U.S.) and at ASU and justified the importance of her research to fill a void within the existing literature. The second chapter illustrated the disproportionately low percentage of females and Hispanics earning bachelor's degrees in engineering at ASU and across the U.S., identified some of the barriers that prevent Latinas from attaining a degree in engineering, and described the programs that address the challenges faced by underrepresented students in engineering. In Chapter Three, the researcher outlined the methodology used to collect and analyze the data for this qualitative action research study. Chapter Four presented the findings of the study, showing that the Latina participants were motivated to persist by their parent's expectations, their desire to overcome obstacles, and their aspiration to become a role model. In this chapter, the author discusses her research findings within a framework of the existing body of literature to determine their implications for practice and future research.

#### **Discussion: Parental Expectations**

In Chapter Four, the researcher contended that the participants' parents' expectations to be successful, achieve at a high academic level, and provide for

their parents were motivators that were integrally responsible for their initial decision to pursue a bachelor's degree in engineering and for their persistence in the degree program. These findings correspond to those of Eccles' (1994) longitudinal study of high school seniors, which found that "girls place more value than boys on the importance of making occupational sacrifices for one's family" (p. 600). Though female students may believe that family-driven occupational sacrifices are more important than male students, the Latina participants in this study placed great value on their family's expectations in their educational and career decision-making processes. Salma's decision to persist in engineering, a field that she was often unsure was a good fit for her, evidenced the importance of her parents' expectations, as she did not want to "waste" the intelligence that they worked to develop in her. Similarly, Paloma's decision to pursue a degree in engineering, rather than dance, also showed this obligation to her family because she knew that aging would limit her career in dance and she was less likely to earn an income that would allow her to support her family. Finally, Rosa faced a tenuous decision whether to enroll in graduate school, torn by her feelings of obligation to financially support her family immediately after graduation, rather than delaying her ability to help for years by earning a graduate degree. In each of these cases, the participants placed a significant importance on the needs of their families, rather than their own occupational desires. Each participant risked her long-term happiness and career satisfaction by pursuing a field that sometimes conflicted with her own educational and career goals, but would better provide for her parents and family.

The participants' parents also expected their daughters to "do well in school." Although in many cases this expectation was not verbalized as the students progressed through their high school educations, most participants felt an unspoken expectation to pursue a college education. Adriana's father stated that he would do anything to help his daughters pay for and achieve an education, because "that's what [their] future depends on." This expectation to pursue postsecondary education is common within the Latino community, as Immerwahr (2000) found that 65% of Hispanic parents identified a college education as "the one thing that can most help a young person succeed in the world today" (p. 5). While Hispanics earned only 7.8% of all bachelor's degrees awarded in the U.S. in 2006 (United States Department of Education, [2006], as cited in National Science Foundation, 2009a), this disparity does not appear to be driven by a gap in different values. As evidenced by the description of the participants' parents in this study, Latino parents value higher education as a necessary means for financial success.

However, the participants whose parents imparted the value of higher education also held an expectation of the participants to complete their bachelor's degree in engineering. Like Salma's mother who "wouldn't have it" when she talked about changing her major out of engineering, the participants felt the expectation of their families and community to graduate in engineering. On the other hand, Seymour and Hewitt (1997) found in their research that, "[f]or the most part, [major] switchers who were black, Hispanic or native American reported their families had been supportive when they changed majors [out of

science, math, or engineering]” (p. 344). For these switchers, the expectation to earn a college degree outweighed the expectation to earn a degree in a STEM field. Because none of the participants in this study switched majors from engineering, it is difficult to predict how their parents would respond. However, the participants’ parents’ expectations were enough motivation to persist and to avoid finding out how their parents would react to switching their majors. This literature and the participants’ stories develop a case that non-persisters in engineering may not have had the same expectations as the Latina participants in this study who were motivated to persist by their parents’ expectations that they would earn a degree in engineering.

### **Discussion: Overcoming Obstacles**

In this study, participants recounted stories of discrimination, stereotyping, and discouragement by faculty, staff, students, and community members. As Hall and Sandler (1982) referenced, female students like Rosa and Isabel experience discriminating classroom gestures, received biased grades, and witnessed professors affirming male students more often than female students. Though originally identified 30 years ago, the findings presented in Chapter Four provide evidence that these biases still occur in engineering classes. These behaviors promote a “chilly climate” in the classroom and make women feel as though their presence is unwelcome, their participation in class has no value, their aptitude for the content is limited, and their goals are unimportant (Hall & Sandler, 1982, p. 3). Unfortunately, this unwelcoming climate extended beyond the classroom and further promoted an unfriendly environment for female students in engineering.

In addition to facing blatant discrimination in the classroom, Isabel also met a non-believer when her academic advisor neglected to support her efforts to recover from failing one class.

Although Rosa and Isabel were motivated to disprove the demoralizing efforts of their professors and advisors, not all students have the strength or determination to fight against this bias and indiscretion. Previous research (Brainard & Carlin, 1998; Hall & Sandler, 1982; Seymour & Hewitt, 1997) argues that experiencing unsupportive relationships, lacking a sense of belonging within their department, and feeling isolated are factors that contribute to the attrition of students in engineering and the sciences. However, the discrimination and stereotyping experienced by the participants in this study did not lead to their attrition in engineering. Participants felt unsupported and discouraged by the faculty and staff members hired to help students succeed in engineering, but the participants were motivated to disprove their faculty and staff's actions and comments by graduating in four years with a bachelor's degree in engineering. While these experiences of bias and intolerance motivated the Latinas in this study toward success, it was an extra responsibility that is commonly placed upon students who are traditionally underrepresented in engineering. This responsibility to overcome discrimination and stereotypes required participants to address an additional obstacle beyond learning the difficult material in their classes.



### **Discussion: Giving Back to the Community**

Eccles' (1994) study of adolescent life transitions revealed that females assign a higher value to “the importance of having a job that allows one to help others and do something worthwhile for society” (p. 600). Interestingly, only a few participants referenced the ability of engineers to improve society as a motivator for choosing and persisting in their major. While Yolanda stated that she wanted to make a difference “not only lives of people, but the planet” through sustainability efforts, Gabriela conversely asserted that helping society was not among her reasons for pursuing engineering, as astronautic engineers would only help society “way in the future” after terrorist encounters with another planet. However, many recruitment efforts by engineering programs focus on how engineers help society by providing sustainable water filtration systems to third-world countries, developing prosthetics and accommodating devices that ease the challenges faced by people with disabilities, or advancing technology and research in other highly emotional situations. Similarly, programs like Engineering Projects in Community Service (EPICS), a series of courses that empowers students to plan, design, and build engineering solutions to community-based problems, are thought to help retain women in engineering because of their focus on helping society. While four of the seven participants enrolled in one semester of EPICS, none of the participants pursued a second semester because the value they gained from the experience did not outweigh the benefits of pursuing an internship or the effort needed to maintain an extra unit of coursework.

Instead of citing the ability of engineers to address society's needs, nearly every participant referenced how earning a degree in engineering would facilitate their ability to contribute to society by broadening the STEM pipeline through educational outreach. In this study, participants were motivated to enroll and persist in an engineering major because they wanted to serve as an example for their younger siblings, be a role model for other disadvantaged children, and to help engineering students as a knowledgeable and experienced resource. This finding was not surprising, since Seymour and Hewitt (1997) contend that the "strongest sense of community obligation was expressed by Hispanic students who unanimously stressed their duty to repay their community" (p. 359). The Latina participants in this study were motivated to attain a degree in engineering by their desire to "something worthwhile for society" (Eccles, 1994, p. 600) and "to repay their community" (Seymour & Hewitt, 1997, p. 359) through outreach, consistent with previous research on females and Hispanics.

Unfortunately, outreach is often given little credit in higher education and does not have the importance of cutting-edge research and visible classroom teaching. The National Science Foundation (NSF) requires every proposal that is submitted to address both the academic merits and the "broader impacts" of the proposed research project. This broader impact condition is the NSF's attempt to promote outreach, educational opportunities, and general benefits to society. Regrettably, "some scientists view the criterion as confusing, burdensome, inappropriate, or counterproductive" ("NSF's 'broader impacts,'" 2007). While this most often refers to the applicants' opinions about how funding should be

allocated based on the value of the proposed research, not their outreach efforts, this requirement provides insight into the disconnect between the values of Latina participants in this study and the priorities of national science leaders and postsecondary institutions.

As Gabriela noted in her interviews, “I feel that if I was given the opportunity to become successful, I should help these kids to get the opportunities to also become successful.” This gratitude for the support and resources that she received played an important role in motivating Gabriela to earn her degree. With her bachelor’s degree in engineering, Gabriela knew that she would be well equipped to financially and intellectually “pay it forward” to other students who deserve the chance to earn a postsecondary degree and pursue a career in the STEM fields. While outreach is often supported in the engineering industry, as we saw through Intel’s visit to Isabel’s grade school classroom, the tangible reward for students and faculty in the university environment is minimal. While educational outreach encourages engineers to think more thoroughly about the ways in which their work affects society and helps to publicize advancements to the general public, few engineering scholarships require outreach to be considered for an award and the Ira A. Fulton Schools of Engineering gives limited recognition to students and faculty who contribute to outreach efforts.

### **Implications for Practice**

The primary purpose of this study was to inform the researcher’s community of practice in Engineering at ASU of the characteristics and experiences of successful Latina persisters in engineering majors. Therefore, it is

important to identify the implications of this research for improving activities, programs, and resources within the Ira A. Fulton Schools of Engineering. The researcher recommends four areas in which that Engineering at ASU administrators can focus their efforts to graduate more Latinas in engineering: expanding recruitment and retention efforts to better include parents and family members; incorporating an ethic of care and personalized education for all students; eliminating the deficit-based approach used for working with underrepresented students; and promoting and compensating service learning and outreach efforts.

### **Recruiting and Retaining Family Members**

Because the expectations of parents were integral to the participants' initial decisions to pursue engineering and their persistence within the field, it is important for engineering administrators to acknowledge the role of family in the success of Latinas. Consequently, it is imperative to increase efforts to recruit and retain the parents of incoming Latina engineering students, not just the students.

In preparing for college, Rosa's mother did not understand the value of a college education and did not know whether her daughter was truly capable to succeed in a collegiate environment. She often told Rosa that she was "wasting time" on college admission and scholarship applications. Rosa's support network of teachers, counselors, and friends' parents provided her with the financial assistance, rides to and from school, and other support needed to successfully prepare her to be an engineering student. With more multicultural students, staff,

and faculty representatives from ASU who speak Spanish and identify with these populations, the Ira A. Fulton Schools of Engineering can educate unaware and unsupportive parents about the long-term benefits of an engineering education. With more parental support, students who consider dropping out of college or changing majors may be more likely to persist in an engineering program. Beyond that, Engineering at ASU must encourage parents to set expectations for their children and create a culture within their family that encourages the children's successes throughout their educational journey. Engineering administrators must collaborate with parents to encourage students to persist, despite earning a low grade in an engineering class or being discouraged by a classmate, advisor, or professor.

### **Ethic of Care in Working with Students**

Participants cited significant instances of discrimination, stereotyping, and interactions with non-believers. Because victims of this oppression often choose to withdraw from the STEM majors to enroll in a field that is more accommodating of their diverse perspective and cultural value (Seymour & Hewitt, 1997), it is necessary to provide more education for faculty and staff. All faculty and staff should receive up-to-date training on the value of diversity, sensitivity to the unique needs and backgrounds of students, and strategies for working with multicultural populations. This training would better prepare instructors to identify their own biases and prejudices, change their attitudes and adapt their teaching methods to avoid expressing stereotypes to students, and recognize discriminatory acts by students in the classroom and equip instructors

with the skills necessary to diffuse the situation. Latinas must feel that they are wanted within the engineering community, their opinions are valued, and their successes are supported so that they do not face unfair and additional obstacles outside of course material. Referring back to the *ethic of care* (Noddings, 2005) discussed in Chapter Three, faculty and staff must listen to the expressed needs of Latinas and respond accordingly. When students like Isabel seek clarification for discrepancies in the concepts that she learned and the concepts on which she was tested, she should be respected for her viewpoint, provided with the answers to her questions, given the resources needed to succeed, and offered the support to improve her performance in the future, not penalized for being female by a unobservant instructor. Issues of discrimination and stereotyping should not be tolerated.

A committee of noted scientists and engineers proposed 14 of the most-pressing challenges to be addressed by engineers, which are now known as the National Academy of Engineering (NAE) Grand Challenges (2008). One challenge, to “advance personalized learning,” recognizes the individuality of all learners and the need to develop new techniques that do not employ an ineffective, “one-size-fits-all” approach (p. 45). This challenge encourages engineers to design web-based systems for delivering content, develop methods for optimizing the order of material presented in a lesson, and customize existing systems for educational uses (like adapting a system that recommends alternative words or resources in computerized searches for use in teaching a foreign language). While engineering administrators have embraced this challenge to

assist educators, few have realized that the engineering students in their classrooms are individual learners and have yet to adequately embrace the products and systems being developed to improve other students' learning experiences. By utilizing more of these methods, techniques, and systems in engineering classrooms, faculty could avoid exhibiting many of their biases that may come out in teaching and students of all genders, ethnicities, and abilities could learn in an environment that is personalized to meet their individual needs.

### **Eliminating the Deficit Model**

The majority of research and support services address the crises of underrepresented populations from a deficit model. This model assumes that students lack a skill or quality that is needed to succeed, and they can be fixed with more knowledge or skill development. Battles (2009) asserts that “the female-focused intervention model implies the inadequacy of women, an implication that is at odds with their retention and success” (p. 6). By singling out a specific population that is underrepresented in engineering, such as females or Latinos, many well-meaning interventions focus on building the skill set of these students to match the norm. This approach inherently implies that students of these targeted populations are lacking the skills, determination, or preparation necessary to succeed. However, it is important to note that the participants in this study had exceptional determination, as they identified in the “I am” activity and demonstrated by persisting through discrimination, stereotyping, and disbelief. These findings, however, can be interpreted in two ways: one may argue that Latinas do not need targeted interventions, as their determination level was

already above average. Others could argue that determination is obviously a characteristic that is necessary to persist in engineering, and Latinas who are at risk of dropping out should receive services that instill this quality so that they can experience the same level of achievement as their peer Latina persisters. The researcher does not agree with the first interpretation, as the literature examining non-persisters shows that determination is not fostered universally amongst Latinas. Furthermore, the engineering environment should not require such high levels of determination to succeed in the face of unnecessary obstacles.

In either case, it is important for engineering administrators to honor the successes that these students achieve, rather than focusing on their assumed deficits. As Yolanda pointed out, “I’m being part of a small group. It’s kind of cool. It’s kind of a good feeling to be a woman in engineering and be a woman engineer.” Similarly, Adriana noted, “I don’t feel bad that I’m the minority. I feel proud that I am.” Rather than creating a separate resource for Latinas, embrace their pride and encourage them to build community within the current services. For example, rather than creating a separate tutoring center specifically for Latinas, hire Latina tutors in the Engineering Tutoring Center who are familiar with the cultural roles, expectations, and accomplishments of their peers. Furthermore, the researcher recommends creating a mentor/scholar program allowing the Ira A. Fulton Schools of Engineering to recognize the successes of the upper-division student mentors, while simultaneously providing positive messages to lower-division scholars. Although the program should be open to all students, upper- and lower-division students of the same gender and ethnic



backgrounds should be paired whenever possible. By creating relationships between students from similar backgrounds, students may better identify with and become more comfortable with their Latina identity (Hurtado, Milem, Clayton-Pedersen, & Allen, 1999). As a result, Latina students will have a higher sense of self-efficacy and mentors will feel fulfilled through their participation in giving back to others. Just as Isabel wanted to be the resource at E2 Camp who could tell the female freshmen “how it is” and “what they needed to do,” Latina mentors will see this opportunity to guide other Latinas in the engineering community as motivation to persist toward degree attainment in engineering.

### **Value Outreach Efforts**

The Latina participants in this study were motivated to persist toward a bachelor’s degree in engineering because of their desire to serve as role models to their younger siblings, parents, children in the communities in which they were raised, and other engineering students who identified with them. This passion for becoming an exemplar and opening the STEM pipeline should be commended and utilized.

As described in Chapter Two, many Latinas do not choose to pursue engineering in their postsecondary education because they are uninterested in the STEM fields. For those Latinas who do pursue a degree in engineering, many encounter barriers to persistence in engineering when their roles as student and family woman diverge. Students who actively pursue outreach opportunities should be publically commended and financially rewarded for their efforts to increase awareness among Latino families of the benefits of a STEM education

and inspire an interest for STEM fields among Latina students. Not only are these students directly affecting the pipeline of Latinas in engineering, they are also engaging in activities that the findings show motivate their own persistence in engineering. Similar to events like the Fulton Undergraduate Research Initiative (FURI) Symposium where students present their semester's research findings, Celebration of Excellence events that recognize scholarship recipients, and the EPICS Project Palooza at which EPICS students present their team innovations, the Ira A. Fulton Schools of Engineering should host recognition events for students and student organizations who actively pursue educational outreach efforts that increase STEM awareness and involvement among underrepresented populations.

### **Recommendations for Future Research**

Given the fundamental influence of the parents' expectations on the participants' persistence in engineering, more research is needed to thoroughly understand this phenomenon. Qualitative methods, like individual interviews and focus groups, should be used to solicit data from the parents of Latina engineering students to better understand the rationale for their expectations, how expectations are communicated, and the familial context of their expectations. Additionally, a third phase of this action research study could assess the effectiveness of implementing the researcher's recommendations for practice. Future studies could analyze quantitative data and compare the percentage of Latina persisters in cohorts who enrolled in engineering before and after employing the interventions. To provide a holistic view of the culture within Engineering at ASU, future

researchers should also utilize qualitative measures, including individual interviews and observations, to assess any change in the characteristics or experiences of Latina students that affected their persistence in pursuing a bachelor's degree in engineering at Arizona State University. Using multiple cohorts would be especially beneficial to assess the impact of the 2008 interventions implemented by the Ira A. Fulton Schools of Engineering—changing the admissions criteria for freshmen, developing E2 Camp, and requiring participation in the Engineering Residential Community.

As discussed in the literature review in Chapter Two, the existing body of research addresses issues relating to women in engineering and matters associated with underrepresented ethnic minorities in STEM fields. However, there is little research that compares and contrasts the similarities and differences among the differing needs of these populations. Instead, administrators and researchers tend to employ approaches that group together all underrepresented ethnic minorities, address only issues of gender, or fail to address the unique needs of these populations in recruitment and retention efforts. While the data collected in this study reveals insight into the persistence of Latinas in engineering, the findings should not be applied to other populations, such as Hispanic men or African American women.

Further research is needed to determine the motivators, characteristics, and experiences of other underrepresented populations. By stratifying for gender and ethnicity in future action research, practitioners can begin to develop a more thorough understanding of how engineering programs can better accommodate

the customized needs of traditionally underrepresented populations within their community of practice. Although further research may show overlap between the wants, needs, and goals of some subsections of the engineering student population, one should not assume that the findings of this study are transferrable without continued research. Similarly, this study utilized an action research approach, which focused on a specific community of practice within Engineering at ASU. Therefore, the findings should not be generalized to other majors, schools at Arizona State University, or postsecondary institutions across the United States.

This research study was framed around a cohort of Latinas who entered the university as first-time full-time freshmen enrolled in an engineering major. Many students who graduate with a bachelor's degree in engineering do not initially enter as a freshman in engineering. Therefore, future research is needed to explore the characteristics and experiences that affect the persistence of Latinas who are internal and external transfers into engineering. Some research (Walden & Foor, 2008) has been conducted to compare the persistence toward graduation of *persisters* (students who were directly admitted and enrolled in a STEM major), *internal resettlers* (students switched from one STEM major to another), and *in-switchers* (students who began their college career as a non-STEM major and switched into a STEM major later). However, more research is needed to fully understand the differences that exist in the persistence of these three populations. Additionally, further research is needed to investigate the characteristics and experiences of all persisters and non-persisters, especially

females and ethnic minorities, who transfer into engineering from a community college or other postsecondary institution.

### **Conclusion**

At the end of this study, the researcher was able to address both of her research questions: 1. What are the characteristics of successful Latina persisters in engineering? and 2. How do the experiences of Latina students influence their persistence toward a bachelor's degree in engineering? The researcher used a qualitative, action research approach to collect data through interviews and non-participant observation sessions. As a result, the researcher informed her community of practice in Engineering at ASU of her findings, discussed the data collected within the context of the existing body of literature, and provided recommendations for implementing changes in the current programs, activities, and curriculum offered by the Ira A. Fulton Schools of Engineering.

While the researcher is proud of her accomplishments throughout this process—honing her skills as a researcher and providing data upon which decisions can be made to improve retention and graduation rates of Latinas in Engineering at ASU—she is aware that this is among the first steps in her academic journey. This research is only one contribution to the field, and there is critical and urgent need for more research and practice that focuses on the success of Latina students in engineering. Because women earn less than 20% of all bachelor's degrees in engineering and Latinos earn approximately 8% of undergraduate engineering degrees (IPEDS, 2006), a considerable amount of work is needed before Americans will see parity in engineering degree attainment

rates. More research is needed to give a voice to the student populations who are not being heard. More administrators need to utilize that research to modify the services and resources offered to underrepresented students. And more students, staff, faculty, and administrators must care about and actively work toward changing the white male-dominated culture that prevails in engineering by warming the climate to value the populations that are underrepresented in engineering and expanding the pipeline to provide more opportunities for females and underrepresented ethnic minorities in the STEM fields.

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APPENDIX A  
ENGINEERING PLUS ACTIVITIES



<b>Activity</b>	<b>Description</b>	<b>Mandatory</b>	<b>Targeted Population</b>
E2 Camp	A 2 ½ day off-campus residential experience in Prescott which helps students set expectations for their first year, develop a sense of community, acclimate to the university culture, meet upper division students and faculty, learn more about internships, and other professional growth opportunities offered by Engineering	Yes	Incoming first-time full-time freshmen
Engineering Residential Community	All Engineering freshmen are required to live in an Engineering Residential Community. First-year students have the opportunity to enrich their academic experience outside the classroom by living in the engineering residential community in Palo Verde Main & East, or the Barrett Honors Community. The Engineering residential community provides students with access to academic resources such as tutoring and study groups as well as social activities, intramurals, gaming nights and meals with professors. These academic and social activities are designed to help build relationships with peers, mentors and faculty. Additionally, students have access to Peer Mentors, who are upper-division engineering students living in the community.	Yes	Incoming first-time full-time freshmen

Fulton Match	The Fulton Match program is a small community where students enroll in block registration of two to four common courses. It is designed to simplify class registration and support students in their first semester in Engineering. Small groups enable students to connect with other students in their field, easily form study groups, and develop a support network to ease the transition into college life.	No	Incoming first-time full-time freshmen
Engineering Tutoring Center	The tutoring center offers free tutoring services in mathematics, physics, chemistry and engineering courses. In addition, test preparation study groups are encouraged	No	No
Engineering Projects in Community Service	Founded at Purdue in 1995, in Fall 2009 ASU became the latest university to join the EPICS consortium, along with over 20 other prestigious members. In the EPICS GOLD program at ASU, teams of multi-disciplinary students with varying interests and strengths work on projects in a series of service learning classes (EPICS I, II, and III) that solve engineering and technology-based problems with not-for-profit community agencies, schools, and government units.	No	No
Engineering Student Organizations	The engineering school sponsors and coordinates over 40 engineering specific student organizations that engage in professional society activities, engineering competitions, outreach and service projects.	No	Some

Fulton Undergraduate Research Initiative	A program that funds students to conduct research with ASU's top-tier researchers and present their findings at a bi-annual symposium	No	No
Engineering Honors Study Abroad Program	A program designed to provide our students with the opportunity to travel abroad with engineering faculty to study and participate in engineering activities in different countries	No	Honors Students
Internships	Internships help fill the gap between theoretical and applied engineering concepts. It is through internships that students solidify career decisions and develop essential professional skills that employers value. We strive to have every engineering student experience at least one internship before graduation. In addition to enhancing learning, internships create opportunities for full-time employment.	No	No

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(Arizona State University, 2010c)

APPENDIX B

ARIZONA STATE UNIVERSITY  
INSTITUTIONAL REVIEW BOARD APPROVAL

To: Lisa Rodrigue McIntyre  
Fanner

for From: Mark Rouse, Chair SPS  
Soc Beh IRB

Date: 03/28/2011

Committee Action: Exemption Granted

IRB Action Date: 03/28/2011

IRB Protocol #: 1103006195

**Study Title:** The Characteristics and Experiences of Successful Undergraduate Latina Students Who Persist in Engineering

The above-referenced protocol is considered exempt after review by the Institutional Review Board pursuant to Federal regulations, 45 CFR Part 46.101(b)(2).

This part of the federal regulations requires that the information be recorded by investigators in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects. It is necessary that the information obtained not be such that if disclosed outside the research, it could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

You should retain a copy of this letter for your records.

APPENDIX C

RECRUITMENT SCRIPT – PHASE 1

I am a graduate student under the direction of Professor Lisa Rodrigue McIntyre in the Mary Lou Fulton Teacher's College at Arizona State University. I am conducting a research study to understand what characteristics make Latina students successful and how their experiences have affected their persistence in engineering or computer science.

I am recruiting individuals to participate in one face-to-face interview which will take approximately one hour.

Your participation in this study is voluntary. If you have any questions concerning the research study, please call me at (541) 914-4892.

APPENDIX D

INFORMATION LETTER – PHASE 1



March 22, 2011

Dear \_\_\_\_\_:

I am a graduate student under the direction of Professor Lisa Rodrigue McIntyre in the Mary Lou Fulton Teacher's College at Arizona State University (ASU). I am conducting a research study to understand what characteristics make Latina engineering students successful and how their experiences have affected their persistence in engineering or computer science.

I am inviting your participation, which will involve one individual interview that will take approximately one hour in March. You will be asked to describe why you chose to pursue a degree in engineering, the impact of your experiences on your career choice, the characteristics that have made you successful, and your expectations of the engineering field. You have the right not to answer any questions, and to stop the interview at any time.

You must be 18 or older to participate in this study. Your participation in this study is voluntary. If you choose not to participate or to withdraw from the study at any time, there will be no penalty (it will not affect your grades, academic progress, or funding).

Although there may be no direct benefit to you, interview responses will be used to improve extracurricular activities in order to create a more supportive environment for other Latina students in the Ira A. Fulton Schools of Engineering. There are no foreseeable risks or discomforts to your participation.

Your responses will be confidential. The results of this study may be used in reports, presentations, or publications, but your name will not be used. Any use of direct quotations from the interviews will not be attributed to your name.

I would like to audiotape this interview. The interview will not be recorded without your permission. Please let me know if you do not want the interview to be taped; you also can change your mind after the interview starts. The audiotapes and transcriptions will be stored as password-protected files on a secure server, will not be kept with any information linking to the identity of participants, and will be erased three years after completion of the study

If you have any questions concerning the research study, please contact me at [carrie.robinson@asu.edu](mailto:carrie.robinson@asu.edu) or 480.727.8712 or my advisor, Dr. Lisa Rodrigue McIntyre, at [lisa.mcintyre@asu.edu](mailto:lisa.mcintyre@asu.edu) or 480.965.6738. If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at 480.965.6788. Please let me know if you wish to be part of the study.

Sincerely,

Carrie Robinson

APPENDIX E

RECRUITMENT SCRIPT – PHASE 2

I am a graduate student under the direction of Professor Lisa Rodrigue McIntyre in the Mary Lou Fulton Teacher's College at Arizona State University. I am conducting a research study to understand what characteristics make Latina students successful and how their experiences have affected their persistence in engineering or computer science.

I am recruiting individuals to participate in four face-to-face interviews which will take approximately one hour each.

Your participation in this study is voluntary. If you have any questions concerning the research study, please call me at (541) 914-4892.

APPENDIX F  
INFORMATION LETTER – PHASE 2

August 1, 2011

Dear \_\_\_\_\_:

I am a graduate student under the direction of Professor Lisa Rodrigue McIntyre in the Mary Lou Fulton Teacher's College at Arizona State University (ASU). I am conducting a research study to understand what characteristics make Latina engineering students successful and how their experiences have affected their persistence in engineering or computer science.

I am inviting your participation, which will involve four individual interviews that will take approximately one hour each during the summer and/or fall 2011 semester. You will be asked to describe why you chose to pursue a degree in engineering, the impact of your experiences on your career choice, the characteristics that have made you successful, and your expectations of the engineering field. You have the right not to answer any questions, and to stop the interview at any time.

You must be 18 or older to participate in this study. Your participation in this study is voluntary. If you choose not to participate or to withdraw from the study at any time, there will be no penalty (it will not affect your grades, academic progress, or funding).

You may experience personal benefit and growth by reflecting upon your experiences and achievements as a natural part of the interview process. Additionally, interview responses may be used to improve practices and activities to create a more supportive environment for other Latina students in the Ira A. Fulton Schools of Engineering. There are no foreseeable risks or discomforts to your participation.

Your responses will be confidential. The results of this study may be used in reports, presentations, or publications, but your name will not be used. Any use of direct quotations from the interviews will not be attributed to your name.

I would like to audiotape this interview. The interview will not be recorded without your permission. Please let me know if you do not want the interview to be taped; you also can change your mind after the interview starts. The audiotapes and transcriptions will be stored as password-protected files on a secure server, will not be kept with any information linking to the identity of participants, and will be erased three years after completion of the study

If you have any questions concerning the research study, please contact me at [carrie.robinson@asu.edu](mailto:carrie.robinson@asu.edu) or 480.727.8712 or my advisor, Dr. Lisa Rodrigue McIntyre, at [lisa.mcintyre@asu.edu](mailto:lisa.mcintyre@asu.edu) or 480.965.6738. If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at 480.965.6788. Please let me know if you wish to be part of the study.

Sincerely,

Carrie Robinson

APPENDIX G

INTERVIEW PROTOCOL – PHASE 1

Tell me about yourself. Listen for and ask about:

- Childhood
- Family
- Culture
- School
- Friends

Tell me about your decision to major in <major>. Listen for and ask about:

- Experiences that were particularly influential
- The experience most responsible for the decision to major
- Mentors
- Peers
- Parents
- Teachers
- Interests
- Aspirations

What expectations did you have about engineering before you enrolled? Listen for and ask about:

- Workload
- Difficulty
- Culture
- Ability
- Preparation

What were your reasons for coming to ASU? Listen for and ask about:

- Funding
- Proximity to family

Interest in engineering

- What interests you the most about <major>?
- What interests you the least about <major>?

Has your interest in <major> changed over time? Why?

Describe your involvement in out-of-class activities. Listen for and ask about:

- Why they chose specific activities
- To what extent are they involved
- E2 Camp
- Engineering Residential Community
- Engineering Projects in Community Service (EPICS)
- Fulton Undergraduate Research Initiative (FURI) or other research
- Engineering student organizations/clubs
- Study abroad

Describe your experiences with engineering outside of academics. Listen for and ask about:

- Internships
- Relationships with engineers

How have your experiences influenced your interest in engineering?

What has made you successful? Listen for and ask about:

- Interest
- Background
- Experience
- Intellectual strengths
- Teaching
- Peers
- What factor is most influential?

Why do some students not succeed in engineering?

Describe any difficulties or challenges you have experienced as a student in Engineering.

Have you ever considered changing your major out of engineering? If so, why?

How would you describe the atmosphere in the Ira A. Fulton Schools of Engineering?

Being a minority in engineering

- Tell me about being a woman in engineering.
- Do any experiences come to mind that are related to being a woman in engineering?
- Why do you believe there are so few women in the field?
- Tell me about being a Latina in engineering.
- Do any experiences come to mind that are related to being a Latina in engineering?
- Why do you believe there are so few Latinos in the field?

Engineering experience and future

- Describe your perceptions of a career in engineering. Listen for benefits and costs.
- How have your experiences as a student prepared you for a career in engineering?
- What are your career goals?

Is there anything you haven't discussed that you would like me to know?



APPENDIX H

INTERVIEW PROTOCOL – PHASE 2

## Interview 1

“I am” exercise (from Tatum, 2007, p. 20)

- Give interviewee a piece of paper and pen
- Ask her to complete the sentence “I am \_\_\_\_\_” using as many descriptors as she can think of in 60 seconds
- Was this difficult or easy? Why?
- Looking at your list, with which five descriptors do you most identify? Why?

Is “Latina” on your “I am” list? Describe how this identity ranks in your list of descriptors.

How do you define Latino or Hispanic? Listen for and ask about:

- Heritage
- Role in American society
- Differences between terms
- Preference for terminology
- Pride in culture

Tell me about yourself. Listen for and ask about:

- Childhood (activities enjoyed, happiness)
- Family (structure, occupations)
- Culture
- Language
- School (importance, likes/dislikes)
- Friends (ethnicities, genders)
- Geographic area
- Economic status
- Representative of culture

Is “engineer” or “engineering student” on your “I am” list? Describe how this identity ranks in your list of descriptors.

Tell me about your decision to major in <major>. Listen for and ask about:

- Parents/family
- Peers
- Teachers
- Mentors
- Friends or family who are engineers
- Influential experiences
- Interests
- Aspirations (career goals, income, status)
- The factor most responsible for the decision

- Why that specific major

What expectations did you have about engineering before you enrolled? Listen for and ask about:

- Workload
- Difficulty
- Culture
- Ability
- Preparation

What were your reasons for coming to ASU? Listen for and ask about:

- Funding (affordability, financial aid)
- Proximity to family
- Reputation
- Selection process

Is there anything you haven't discussed that you would like me to know?

## Interview 2

What were your goals upon entering college? Listen for and ask about:

- Personal
- Academic (grades, involvement)

Have you achieved those goals? Describe your successes and accomplishments.

Listen for and ask about:

- Personal
- Academic
- Career
- What are you most proud of?

What has made you successful? Listen for and ask about:

- Interest
- Background (preparation, support, ideals)
- Experiences
- Intellectual strengths
- Personality traits (where did they come from?)
- Teachers
- Mentors
- Peers
- Support system
- What factor is most influential?

Tell me about your experiences in classes. Listen for and ask about:

- Professors (best, worst)
- TAs
- Difficulty (hardest, easiest)
- Enjoyment (favorite, least favorite)
- Atmosphere (class format, expectations)
- Group work

Are you pursuing a minor or second major?

- Why or why not?
- How would that field compliment engineering?

Describe your involvement in out-of-class ASU activities. Listen for and ask about:

- Why they chose specific activities
- Level of involvement
- E2 Camp
- Engineering Residential Community
- Engineering Projects in Community Service (EPICS)
- Fulton Undergraduate Research Initiative (FURI) or other research
- Engineering student organizations/clubs

- Non-engineering activities
- Study abroad

Describe your experiences outside of ASU that influenced your persistence in engineering. Listen for and ask about:

- Internships
- Jobs (engineering-related vs. non-engineering)
- Relationships with engineers
- Community (neighborhood, church)
- Mentorship

Describe any difficulties or challenges you have experienced as a student in Engineering.

Have you ever considered changing your major out of engineering? If so, why?

Being a minority in engineering

- Tell me about being a woman in engineering.
- Do any experiences come to mind that are related to being a woman in engineering?
- Tell me about being a Latina in engineering.
- Do any experiences come to mind that are related to being a Latina in engineering?

Why do some students not succeed in engineering?

- Why do you believe there are so few women in the field?
- Why do you believe there are so few Latinos in the field?

How could the Ira A. Fulton Schools of Engineering make you more successful?

Future in Engineering

- What are your career goals?
- How have your experiences as a student prepared you for a career in engineering?

Describe your perceptions of a career in engineering. Listen for and ask about:

- Benefits
- Costs
- Making a difference in other people's lives
- Finding solutions or meeting the needs of society
- Personal intellectual growth
- Satisfaction from achieving goals

Is there anything you haven't discussed that you would like me to know?

APPENDIX I

RECRUITMENT SCRIPT – OBSERVATION

As many of you know, I am a graduate student in the Mary Lou Fulton Teacher's College at Arizona State University. I am conducting a research study to understand what characteristics make Latina students successful and how their experiences have affected their persistence in engineering.

I'm requesting permission to observe the executive board meetings of the [student organization]. I've distributed a document that includes more details about the study.

The E-board's participation in this study is voluntary. If you have any questions concerning the research study, you may speak with me at any time. I can be reached at (541) 914-4892 or [carrie.robinson@asu.edu](mailto:carrie.robinson@asu.edu).

APPENDIX J  
INFORMATION LETTER – OBSERVATION



December 15, 2011

Dear [student organization] Executive Board:

I am a graduate student under the direction of Professor Lisa Rodrigue McIntyre in the Mary Lou Fulton Teacher's College at Arizona State University (ASU). I am conducting a research study to understand what characteristics make Latina engineering students successful and how their experiences have affected their persistence in engineering or computer science.

I am requesting the opportunity to observe the executive board meetings of the [student organization]. I will continue to serve in my capacity as your advisor and my observation will not interrupt the meetings in any way. I will not video or audio record the meetings, but I will take notes during and after the meetings. You have the right to revoke my permission to observe the meetings at any time.

You must be 18 or older to participate in this study. Your participation in this study is voluntary. If you choose not to participate or to withdraw from the study at any time, there will be no penalty (it will not affect your grades, academic progress, or funding). Individual participants will be anonymous in my notes and in the presentation of study findings. The results of this study may be used in reports, presentations, or publications. Any use of direct quotations will not be attributed to a member's name.

Although there may be no direct benefit to you, findings from this study will be used to improve extracurricular activities in order to create a more supportive environment for Latina students in the Ira A. Fulton Schools of Engineering. There are no foreseeable risks or discomforts to your participation.

If you have any questions concerning the research study, please contact me at [carrie.robinson@asu.edu](mailto:carrie.robinson@asu.edu) or 480.727.8712 or my advisor, Dr. Lisa Rodrigue McIntyre, at [lisa.mcintyre@asu.edu](mailto:lisa.mcintyre@asu.edu) or 480.965.6738. If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at 480.965.6788. Please let me know if you wish to be part of the study.

Sincerely,

Carrie Robinson