Achieving success in engineering: A phenomenological exploration of Latina/o student persistence in engineering fields of study

by

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DEDICATION

To the young Latina/o students who aspire to go to college one day. May your journey be empowering and fulfilling.

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DEFINITIONS OF TERMS

Today there continues to be an inescapable quandary when studying or referencing people of Hispanic and Latina/o ethnicities. People have personal and political preferences and often passionate opinions when identifying their race or ethnicity. For this investigation, the terms *Hispanic* and *Latina/o* were used interchangeably.

1. **Hispanic:** *Hispanic*, from the Latin word for "Spain," has the broader reference, potentially including all Spanish-speaking peoples in both hemispheres and emphasizing the commonality of language among communities that sometimes have little to nothing else in common (American Heritage Dictionary, 2000; Jones & Castellanos, 2003). This term was first introduced by the U.S. Office of Budget and Management in 1978.
2. **Latina/o:** *Latino*, which in Spanish means "Latin," but which as an English term is probably a shortening of the Spanish word *latinoamericano*, refers more exclusively to persons or communities of the western hemisphere and of Latin American origin (American Heritage Dictionary, 2000; Jones & Castellanos, 2003).
3. **Hispanic versus Latino:** Both terms are used interchangeably in this study and in the United States. Many groups reject the term *Hispanic* because of its broadness and because it was given to the Latina/os by the United States government without consent (Jones & Castellanos, 2003). However, there are certain regions in the United States and certain groups of people who prefer the term *Hispanic* over *Latino.* It must be recognized that many college students may prefer one

term over the other, and it remains a personal preference in the United States today.

4. **Retention:** The ability of an institution to retain a student within the system of higher education or at a specific institution of higher education.
5. **Persistence:** The desire and action of a student to stay within the system of higher education or at a specific institution of higher education from beginning of college to degree completion.
6. **Retention Rate:** The percentage of people who are retained by the institution of higher education or continue on with their bachelor's degree into the next academic term.
7. **Graduation Rate:** The percentage of people/students who graduate from any given institution, college, or department.
8. **Attrition:** Failed re-enrollment of a student in education in consecutive academic terms. Also known as dropout.

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I could not have partaken in this learning adventure alone. I am able to present my work because of the people who helped me, the writer, through the sometimes seemingly endless journey of inquiry. First, I would like to thank my family—Mom, Dad, and Natalie (my best friends)—who have sacrificed so much so that I could pursue my own life journey. Also, my partner Lee has stood with me over these years, and without his patience and understanding, this project would have been more difficult than it already has been. I will also be in debt to Dr. Laura I. Rendón, my major professor and mentor, who gave endless time and patience so that I could develop as a scholar and present my research in the best possible light. I am also grateful to my two faculty advisers, Dr. Nana Osei-Kofi and Dr. Marta Maldonado. Without the help of such profound and erudite women, I would not be where I am today. Finally, I owe the most to my student participants. They know who they are, and while they remain unknown in this investigation of their experiences, they are the people who inspire me.

PROLOGUE

It is here that I begin my journey into understanding what experiences enhance or preclude the persistence of Latina/o engineering students. One may ask what brings researchers to this type of investigation of what I believe to be an often subjugated and under heard population like Latina/os. For me, the researcher, taking this journey is a personal adventure with my life experience as a first-generation college student, brother, son, and partner serving as my inspiration. I am passionate about studying how Latina/o students persevere in educational environments and cultures laden with bias and stereotypes. Growing up in an upper middle-class family with a Mexican father and an Irish mother who never went to college showed me that not all Latina/os are poor and ignorant to the value of education. My parents proved that Latina/os do not need formally educated parents to show a young son or daughter the value and excitement of pursuing a higher education. It is because of my family's encouragement and unwavering support that I am able to be present for this important work. It is my hope that my work will contribute to knowledge that seeks to emancipate humans who are embedded within a system of oppression like Latina/os in higher education institutions.

The Latina/o population is now the largest minority population in the United States. While the Latina/o population is diverse in its own ways, both socially and economically, Latina/os experience a less than hopeful educational future. It is widely known that Latina/os have the highest college dropout rates of any racial or ethnic group in the United States (Garrod, Kilkenny, & Gomez, 2007; Nora, 2003). In 2001, National Center for Education Statistics (NCES) data showed that of all bachelor's degrees awarded, only 7% were awarded to Latina/os, while 72% were awarded to the non-Latina/o White population (see Table 1.4).

Furthermore, relevant to this study, it is also alarming that in 2001 only 7.3% of U.S. engineering bachelor's degrees were awarded to Latina/os (see Table 1.5). Naturally, I must ask why the degree attainment rates remain so low considering the major U.S. population increase of Latina/os in the recent decades of American history.

Throughout my graduate and undergraduate education I have been presented with literature shedding light on Latina/o students as being from poor immigrant families who do not value education and remain unassimilated into the "American way." I was frequently left with the impression that research produced and distributed to our young students was presenting Latina/os as a population with deficits in need of rescue. These impressions may be true in some cases; however, as this study shows, Latina/o students come from all walks of life and represent a group of students who are supported by their families to pursue a better future through educational avenues and aspirations. Latina/os, just like all racial and ethnic populations, may not always have economic resources but may exhibit strong will and desire to attain a life far more advanced than the generations that paved the path before them. For that reason, I seek to increase educational access for students of color, especially in the science, technology, engineering, and mathematics (STEM) fields of study.

I would like to begin my inquiry by introducing the readers of my investigation with a verse from *Por Eso Canto* (That's Why I Sing), a song performed by radical and renowned Puerto Rican singer Willie Colón (as cited in Padilla, 1997). The verse represents my thoughts on why I can no longer exist as a passive observer. I believe it is my time to learn, act, and bring light to the often untold adventures of Latina/o students who persist through educational environments lacking the foundations essential for Latina/o student success. The

following verse from *Por Eso Canto* eloquently articulates my motivation behind this important work.

> I cannot remain silent in light of what surrounds me,
>
> neither can I ignore those who suffer from a thousand sadnesses,
>
> to sing for singing sake has no meaning.
>
> I want to sing because I feel a commitment.

Achieve success and enjoy!

ABSTRACT

This study explored the factors that precluded or enhanced Latina/o student persistence in engineering fields of study at Iowa State University (ISU). The study employed a phenomenological methodology. Nora's (2003) Model of Student Engagement and Rendón's (1994) model of validation were used as the theoretical framework. Focus group interviews were employed to explore the pre-college, academic, and social experiences of Latina/o engineering majors while enrolled at ISU. A Model of Latina/o Student Success in Engineering (Figure 5.1) was developed and characterized the three main determinants that facilitated student success in engineering fields of study. The three indicators of success were: (a) pre-college experiences, (b) academic experiences, and (c) social experiences. Pre-college determinants that facilitated success included family support and institutional commitment. Academic experiences that facilitated success were academic engagement and validating interactions among students and faculty. Social experiences also influenced student success by engaging students in relationships of peer support and mentoring. Recommendations were offered to aid the higher education community in implementing student success in their engineering programs.

CHAPTER 1. PROBLEM AND PURPOSE

Introduction

This study is based on two key problems confronting American higher education and specifically Iowa State University (ISU). The first problem is the lack of research related to Latina/o student persistence in engineering programs at the baccalaureate level. While enrollment of Latina/o students in engineering has grown steadily over the past 20 years, little is known about their social and academic experiences while they are enrolled in engineering programs. Understanding the academic experiences (i.e., contact with faculty, special academic programs, remediation, etc.) and social experiences (i.e., peer networks, special events, programming, etc.) of Latina/o students in college will help higher education administrators to better understand the reasons Latina/o students elect to stay or leave their engineering program where they exist as an undersized minority. Overall, Latina/o students accounted for 6.3% of bachelor's degree recipients in 1999–2000, but 8.1% of first-time, full-time freshmen enrollments in 1999 (Swail, 2003). Specifically, Latina/o students accounted for 7.2% of science and engineering bachelor's degrees awarded in 2000 (Educational Testing Services [ETS], 2003). The second problem relates to the poor participation and retention of Latina/o students in engineering at ISU. In 2006 ISU conferred bachelor's degrees in engineering to 862 men and women. Of the 862 engineering degrees awarded, only 11 went to Latina/o students (Iowa State University Engineering College Office of Graduate Studies, 2006a). The lack of Latina/o participation in engineering is problematic because Latina/os are now the largest minority population in the United States; however, formal educational achievement of Latina/os in engineering has not increased significantly (de los Santos, Keller, Nettles, Payan, & Magallan, 2006).

In order to remain economically competitive, the United States will require a more technically educated workforce than currently exists (Chang, 2002). In fact, the field of engineering is becoming more global, requiring engineering professionals to work and compete on an international level (Chang). At the same time Latina/os, the largest minority in the United States, are falling behind in the educational system instead of raising their academic achievements, especially in the science and technology fields (de los Santos et al., 2006). As a result, many different types of organizations have worked hard to strengthen the academic pipeline for Latina/o students in America (de los Santos et al.).

Historical Context

Access to higher education has seen a dramatic shift for the better during the past 40 years in the United States. Higher education is an important vehicle for many social benefits such as long-term economic growth, healthier populations, and increased civic participation (Price & Wohlford, 2005). Expanding access to higher education was an explicit priority in the United States with the passage of the Higher Education Act of 1965. The results of this legislation have been remarkable with increased access and attainment for people from all racial, social, and gender groups (Price & Wohlford).

Traditionally, Latina/os have been underrepresented in the engineering field (Anderson-Rowland et al., 1999). This is still the case even though it has been over 30 years since the first Minority Engineering Program was formed in 1970 at California State University, Northridge (Anderson-Rowland et al.). Even with the increased population of Latina/os in the United States, they remain low in the numbers of undergraduate enrollment in engineering programs. The Engineering Workforce Commission's (2003) most current comparative data showed that Hispanic students account for 8% of the total enrollment in

engineering programs in the United States, while White students account for 72% (Table 1.1).

Table 1.1

National Comparative Data on Undergraduate Enrollment in Engineering Programs

Enrollment Sum	Total	Asian/Pacific Islander	Black	Hispanic /Latino	American Indian/Alaskan Native	White
#	398,048	49,696	26,433	33,311	2,362	286,246
%	100	12	7	8	1	72

Note. Engineering Workforce Commission (2003). Engineering & Technology Enrollments: Fall 2002. Washington DC. Racial/ethnic breakouts are for U.S. citizens and permanent residents only.

Minority students have long been underrepresented in the fields of science, technology, engineering, and mathematics (also known as STEM fields) at America's colleges and universities (National Science Foundation [NSF], 2000). When science education is taught with competitive and quantitative environments, the science, math, and engineering routes close to minority students at the pre-college level (Brown, 2002). Therefore, by the time a minority student makes it to college, their journey has experienced barriers related to their educational attainment. Additionally, once a student enrolls in a university, he/she may experience lack of support and validation in the college classroom. According to Brown, science educators have not made it possible for all students to feel comfortable and accomplished in science classrooms around the United States. This has resulted in students possibly leaving engineering environments where they feel they have nothing to contribute.

National Perspective

National data showed that 40% of Latina/o college undergraduate engineering majors eventually leave their program (Seymour & Hewitt, 1997). Moreover, only 10.8% of high school graduates stated that they intended on majoring in engineering while in college (National Science Board [NSB], 2006). Clearly, many Latina/o students in engineering programs are not finding their niche or are caught up in academic hardships, forcing them to resort to easier ways of life in other degree programs or leaving the institution all together.

National Demographics

The nation's educators cannot ignore the fact that college students are becoming more diverse in terms of race and ethnicity, as well as in class, beliefs, and lifestyles (Rendón, Garcia, & Person, 2004). According to U.S. Census Bureau (2004) data, the United States is 67.3% White. This means that of all Americans, roughly one out of three people is from a minority population. Moreover, the Latina/o population in the United States has grown to all time highs. Latina/os are now the largest minority population in the United States with nearly 41.3 million people or 14.1% of the total U.S. population (Table 1.2).

Table 1.2

United States Population by Race/Ethnicity, 2004

Total U.S. Population 293,655,404	White	African American	Hispanic	Asian	American Indian/ Alaskan Native	Native Hawaiian/ Pacific Islander	Multiracial /Bi-racial
%	67.3	12.2	14.1	4.2	0.8	0.1	1.3
No. in Millions	197.9	36	41.3	12.2	2.2	0.4	3.9

Note. Annual Estimates of the Population for the United States and States, and for Puerto Rico: July 1, 2004, U. S. Census Bureau (NST-EST2004-01). Population Division, U.S. Census Bureau, 2004.

Attrition Rates of Latina/o Students in Higher Education

The especially low degree attainment rates for Latina/os in higher education are attributable to the subsequent exceedingly high attrition rates among the Latina/o student population (Nora, 2003). According to Nora (2003), high attrition rates among Latina/os in higher education are attributable to three major aspects: (a) first- to second-year persistence rates in community colleges, (b) first- to second-year persistence rates for students enrolled in a four-year institution without having transferred to the four-year university, and (c) first- to second-year persistence rates for transfer students in higher education (Nora). Table 1.3 demonstrates that attrition rates for Latina/os are 1.3 times higher than White students and almost 1.5 times larger for Asian American students (Nora).

Table 1.3

Attrition Rates of Different Ethnic Groups in Higher Education

Race/Ethnicity	First- to Second-year Attrition Rates, %
Latino	54.4
African-American	63.3
Asian-American	37.2
White	41.5

Note. Nora, 2003

Degree Attainment

Hispanic college students consistently had the lowest college completion rates between 1975 and 2000 (Kurlaender & Flores, 2005). Nationally, Latina/o students have the lowest baccalaureate completion rates among minorities groups at 9.23% (Kurlaender & Flores). With that said, Latina/os have become the population with the lowest rate of post-secondary entry into four-year degree programs at 29.83%, and the highest with respect to

post-secondary entry into two-year degree programs at 45.22% (Kurlaender & Flores). Furthermore, Hispanics are less likely than Whites to graduate from college. In 2003, among those who were 25- to 29-years-old and had completed high school, 18% of Hispanics, compared to 34% of Whites, had earned bachelor's degrees or higher (NSB, 2006). Among Hispanics, about one-third of degrees awarded were in science and engineering majors (NSB). Moreover, in 2004 only 10.8% of Hispanic high school graduates intended on majoring in engineering programs (NSB). Additionally, STEM programs suffer from the lack of student success of non-white students. According to the National Science Board, as of 2002 the United States needs to educate an additional 1.9 million scientists over the next 10 years. To fill this need, students of color can play a vital role. However, an obstacle to meeting this demand is the low minority student persistence rates when compared to the general student population (Chang, 2002).

Degree attainment of bachelor's degrees and advanced degrees is also an area of concern. Hispanics make up less than 10% in every degree category. According to National Science Foundation data, White students account for 72% of the total bachelor's degrees attained in all fields, while Hispanic students receive 7% of the total degrees (Table 1.4). Engineering bachelor's degree attainment remains low as well, with White students making up 70.7%, and Hispanic students only 7.3% of the total (Table 1.5). For master's degrees in engineering, White students make up 73%, and Hispanics make up 3.8% of the total master's degrees attained (Table 1.6). Finally, with respect to doctoral engineering degrees, White students receive 71.9%, while Hispanic students make up 4.7%, of total doctoral degrees (Table 1.7).

Table 1.4

Total Bachelor's Degree Attainment by Race/Ethnicity

	White	Asian/Pacific Islander	Black	Hispanic/ Latino	American Indian/Alaskan Native	Unknown	Total
#	888,412	75,496	106,648	89,972	8,664	48,997	1,218,169
%	72	6	9	7	1	5	100

Note. National Science Foundation, Division of Science Resources Statistics, special tabulations of U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey, 2001. Racial/ethnic breakouts are for U.S. citizens and permanent residents only.

Table 1.5

Total Engineering Bachelor's Degree Attainment by Race/Ethnicity

	White	Asian/Pacific Islander	Black	Hispanic/ Latino	American Indian/Alaskan Native	Unknown	Total
#	38,767	7,025	2,884	4,016	256	1,891	54,839
%	70.7	12.8	5.3	7.3	0.5	3.4	100

Note. National Science Foundation, Division of Science Resources Statistics, special tabulations of U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey, 2001.Racial/ethnic breakouts are for U.S. citizens and permanent residents only.

Table 1.6

Master's Degree Attainment in Engineering Programs by Race/Ethnicity

	White	Asian/Pacific Islander	Black	Hispanic/ Latino	American Indian/Alaskan Native	Unknown	Total
#	13,381	2,572	665	711	43	1,109	18,931
%	73	13.6	3.5	3.8	0.2	5.9	100

Note. National Science Foundation, Division of Science Resources Statistics, special tabulations of U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey, 1995–2002.

Table 1.7

Total Engineering Doctoral Degrees by Race/Ethnicity

	White	Asian/Pacific Islander	Black	Hispanic/ Latino	American Indian/Alaskan Native	Unknown	Total
#	1,556	339	75	103	11	73	2,163
%	71.9	15.7	3.5	4.7	0.5	3.7	100

Note. National Science Foundation, Division of Science Resources Statistics, Survey of Earned Doctorates, 2003.

State Perspective—Iowa

Iowa is a manufacturing- and agriculturally-driven state and economy. The state of Iowa has long been known for farming and education but not diversity. Iowa saw a 13.4% increase in the total population between the years 1990–2000 (Harring & Krob, 2005). In 2005 the population had reached 2,966,334 and is projected to decrease by the year 2030 to 2,955,172 (Table 1.8).

Table 1.8

Total Iowa Population

	2000	2005	2030
Population #	2,926,324	2,966,334	2,955,172
U.S. State Population Ranking	30	30	N/A

Note. State Data Center of Iowa. Iowa Quick Facts (2005).

Iowa Population

Every year the state of Iowa publishes it's *Iowa Quick Facts* through the State Data Center of Iowa (SDCI). According to state data in 2004, the total population was 91.7% White and only 8.3% minority. Of the minority populations, Latina/os are the largest

minority in the state of Iowa at 3.5% (Table 1.9). All other minority groups consisted of less than 2% each (State Data Center of Iowa, 2004).

Table 1.9

Iowa Population Comparative Data, Race/Ethnicity

	White	African American	Asian	American Indian/Alaskan Native	Native Hawaiian/Pacific Islander	Hispanic	Other	Total
#	2,720,128	65,259	41,528	889	0	103,821	2,669	2,966,334
%	91.7	2.2	1.4	0.3	0	3.5	0.9	100

Note. State Data Center of Iowa. Iowa Quick Facts (2005).

Iowa Higher Education

The state of Iowa has long been known for its high quality educational system. The Regents' universities of the state allow for access to public education. The Regents' universities consist of the University of Iowa (UoI), ISU, and University of Northern Iowa (UNI). The total student population of the Regents' university system is 67,701 students. In Iowa Latina/o students make up less than 5% of the student body at each of the three Regents' universities (Table 1.10 and 1.11).

Table 1.10

Total Enrollment In Iowa Regents' Universities

	Fall 2006	Fall 2005
Total Enrollment	67,701	67,896
Undergraduate Enrollment	51,880	51,894
Graduate Enrollment	11,529	11,551
Minority Population Enrollment	5,655	5,557

Note . Board of Regents, State of Iowa. Residence System Governance Report (2006).

Table 1.11

Iowa Regent Universities Campus Enrollments, 2005 Enrollment

	Total	White %	African American %	Asian/Pacific Islander %	Hispanic %	American Indian/Alaskan Native %	Other/Internationa l %
ISU	25,471	83.6	2.8	3	2.1	0.3	8.2
UoI	29,642	91	2.3	3.6	2.6	0.5	N/A
UNI	12,513	87.1	3.3	1	1.5	0.2	6.9

Note. Board of Regents, State of Iowa. Residence System Governance Report (2006).
Iowa State University, Institutional Research, 2006, University of Iowa, Fact Book: Enrollment 2005, 2006, University of Northern Iowa, Institutional Research, Fact Book 2005-2006, 2006.

While minority student enrollment is low, the retention rates of the university system remain high. Each Regent's university had 2005 first-year student retention rates above 80%. First year retention rates for each of the three Regents' universities are: ISU, 84.7%; UoI, 83.2%, and UNI, 81.4% (Board of Regents, State of Iowa, 2006)

Engineering enrollments are high in the state of Iowa. Both the UoI and ISU have engineering colleges. At ISU, the College of Engineering has the largest student enrollment of any of the university's eight colleges. At the UoI, engineering students represent the second largest undergraduate major. However, enrollment in engineering by Latina/os at both of these schools remains low (Table 1.12). At ISU, Latina/os make up 2.8% of engineering undergraduates, and the UoI Latina/os make up only 1.9% of engineering students.

Table 1.12

Enrollment of Latinos in Engineering Colleges at Two Iowa Regent Universities

	Total enrollment in engineering	Total Latinos in engineering	Latinos in engineering %
ISU	4,551	99	2.8
UoI	1,108	21	1.9

Note. Iowa State University, Institutional Research, 2006.University of Iowa College of Engineering, Enrollments Spring 2006.

Iowa State University Perspective

As one of only three Regents' universities in the state of Iowa, ISU accounts for the highest student enrollments and degrees awarded in the engineering disciplines. The following information is provided to bring the data at ISU into the discussion on the lack of participation by Latina/os in engineering undergraduate programs at ISU.

Graduation Rates

At ISU only 2.1% of the undergraduate student body is Latina/o (Table 1.11). According to the Office of Institutional Research at ISU (2006), Latina/o students who entered to pursue a bachelor's degree at ISU in 1999 graduated in four years at a rate of 24%, and in six years at a rate of 66.7% (Tables 1.13 and 1.14). The data regarding engineering degrees awarded warrant great concern. The ISU Engineering Office of Graduate Studies (2006a) data showed that the engineering college at ISU awarded 862 bachelor's degrees to its students in 2006. Of the 862 degrees awarded, only 11 (1.2%) went to Latina/o students (Table 1.15).

Table 1.13

Overall 4-year Graduation Rates of Undergraduates at Iowa State University

	Graduation Rates 1999	Graduation Rates 2000	Graduation Rates 2001
African American	16.6	22.1	11.3
Asian	20.9	28.3	29.5
White	32.2	32	33
Latino	24	27.2	25.3

Note. Iowa State University, Office of Institutional Research. (2006). Fact Book 2005-2006.

Table 1.14

Overall 6-year Graduation Rates of Undergraduates at Iowa State University

	Graduation Rates 1999	Graduation Rates 2000	Graduation Rates 2001
African American	43.6	36.5	51
Asian	67.7	56.8	59.3
White	66.8	68.1	68.9
Latino	58.8	54.7	66.7

Note. **Iowa State University, Office of Institutional Research. (2006). Fact Book 2005-2006.**

Table 1.15

Degrees awarded to Latinos in the College of Engineering at Iowa State University 2003-2006

	2003	2004	2005	2006
Total degrees awarded	850	806	813	862
Total degrees awarded to Latinos	8	14	22	11
Total degrees awarded to Latinos %	0.9	1.7	2.7	1.2

Note. Iowa State University, Engineering Office of Graduate Studies, 2006. Unpublished raw data.

Engineering Retention

According to the ISU Engineering Office of Graduate Studies (2006b), engineering retention rates are low for Latina/o students when compared to White students. In fact, just getting Latina/os to enroll in engineering at ISU has shown to be a challenge, and the enrollment of Latina/os in engineering is significantly lower than that of their White peers. The total number of students admitted during the fall of 2005 in the College of Engineering was 767 first-year undergraduates, and Latina/os made up 3% of first-year students (Table 1.16). The total retention for all students at the end of their first year was 87.9% (Iowa State

University Engineering College Office of Graduate Studies, 2006b). Additionally, White students had a first-year retention rate of 87.8%, while Latina/o students were retained at a rate of 95.7%. In other words, 22 out of the 23 Latina/o students admitted in the fall of 2005 continued into their second year (Table 1.17).

Table 1.16

2005 Total Undergraduate First Year Admission to Engineering at ISU

	African American	American Indian	Asian	Hispanic	White	Unknown	Total
#	15	1	24	23	681	23	767
%	2	0.1	3.1	3	88.8	3	100

Note. ISU Engineering Office of Graduate Studies, 2006.

Table 1.17

2005 First Year Retention Rates of Engineering Students at ISU

	African American	American Indian	Asian	Hispanic	White	Unknown	All student retention
#	12	1	22	22	598	21	686
%	80	100	91.7	95.7	87.8	91.3	87.9

Note. ISU Engineering Office of Graduate Studies, 2006.

Once students transition through their first year, the number of students who persist begins to decrease. The four-year retention rates of Latina/o students in engineering at ISU warrant some concern. Of the 23 students enrolled for the first time in 2000, one Latina/o student graduated after four years, and only 11 students continued on into their fifth year. The retention rate for the fourth year was only 47.8%. Of the 600 White students who enrolled in 2000, 103 students or 17.3% graduated in four years, and 56.7% continued on

into their fifth year (Tables 1.18 and 1.19). The data suggested that Latina/o students chose to leave the engineering college between the first and fourth year of their education.

Table 1.18

ISU Engineering 4-year Retention Rates of Undergraduates by Race/Ethnicity, Entering ISU 2000

	African American	American Indian	Asian	Hispanic	White	Unknown	All student retention
%	41.7	0	52.9	47.8	56.7	42.4	54.1

Note. ISU Engineering Office of Graduate Studies, 2006.

Table 1.19

ISU Engineering 6-year Retention Rates of Undergraduates by Race/Ethnicity, Entering ISU 2000

	African American	American Indian	Asian	Hispanic	White	Unknown	All student retention
%	0	0	5.9	4.3	1.8	3	2.1

Note. ISU Engineering Office of Graduate Studies, 2006.

Problem and Purpose of the Study

Given the data presented in the previous section, the specific problem to be investigated in this study is the relatively poor persistence of Latina/o students in bachelor's degree programs in engineering. In particular, the study will focus on Latina/o undergraduate students enrolled in the College of Engineering at ISU, a predominantly-white institution (PWI) located in central Iowa focusing on technological and scientific education and research.

The purpose of this investigation is to conduct an exploratory study to account for the experiences which may impact persistence of Latina/o students in an engineering program at ISU. It is important to know how these students persist, and what factors in the engineering

culture detracts them from their academic experience once they enroll in the institution. Since persistence and graduation of Latina/o students in engineering are essential to meeting the job market demands of the future, it is important to examine undergraduate students in order to unlock the reasons why many Latina/o students decide to stay away from the engineering profession. Examining current students in engineering will allow us to see what has worked and what had discouraged Latina/o students' educational journeys and even possibly caused them to drop out of engineering altogether. Finally, a study of Latina/o student persistence in engineering will address an avenue of research that has been unexplored in past years.

Significance of the Study

The Latina/o population in the United States has grown to an all time high (Table 1.1). Increases in Latina/o student enrollment has also been documented in higher education. However, the persistence of Latina/os in engineering programs remains problematic. Consequently, research needs to be conducted to account for the experiences that enhance or preclude Latina/o student persistence in engineering programs. Below are the implications of this study for practitioners and policy makers.

Higher Education Practitioners

For the purposes of this study, practitioners include both student affairs administrators and faculty. This study is important to their work for the following reasons:

1. The institution's student and faculty composition as well as racial/ethnic climate may have a significant impact on the persistence of Latina/o engineering undergraduates. Therefore, the study's data can assist practitioners in designing curricula and student services for a diverse student population.

2. Typically, curriculum in engineering uses hard sciences and traditional pedagogy to teach students. Understanding the academic experiences of Latina/o students in engineering can allow practitioners to design new and effective ways of teaching students in science and engineering disciplines.
3. Knowing what derails and retains a Latina/o engineering major will help practitioners be more careful and strategic in their work. Knowing about the students who come to faculty and student affairs professionals for assistance and guidance will allow practitioners to serve Latina/o students better.

Significance for Higher Education Administrators and Policy Makers

In addition to practitioners, higher education administrators and policy makers will benefit from this study because of the influence they have on public and institutional policy in higher education. For example:

1. Policy in the institution is often guided by research findings. This study can provide qualitative and quantitative data to the bank of information and research used to design and improve policy.
2. Personal accounts of Latina/o students' experiences will help give personal testimony to the often political influence asserted in policy making.
3. This research will help raise the awareness of the need for outreach and retention of students once they are recruited and enrolled. How to help create systems that move students through the engineering program more effectively will be learned.
4. Knowing the specific occurrences that retain or distract Latina/o students in engineering will help justify increased funding for retention efforts and initiatives for Latina/o engineering students.

Research Questions

This study is guided by the following research questions that generated the research protocol used to interview Latina/o students in engineering majors at ISU in a focus group setting (Appendix A) and survey instrument (Appendix B).

1. What are the characteristics of Latina/o students in the College of Engineering at ISU (i.e., personal and educational demographics, family support, pre-college experiences, and college academic accomplishment)?
2. What pre-college experiences of Latino students in engineering enhance or preclude their persistence in engineering at ISU?
3. What academic experiences of Latina/os (i.e., contact with faculty, special academic programs, remediation, etc.) enhance or preclude their persistence in engineering at ISU?
4. What social experiences of Latina/os (i.e., peer networks, special events, programming, etc.) enhance or preclude their persistence in engineering programs at ISU?

CHAPTER 2. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

Introduction

This chapter will examine significant research findings related to the academic persistence and success of Latina/o students in higher education with a focus on engineering fields of study. Accordingly, this chapter will focus on four areas: (a) K–12 influences on college persistence, (b) general factors associated with the retention of Latina/os in higher education, (c) experiences that foster success for Latina/os in engineering, and (d) the theoretical framework which contextualizes this study.

K–12 Influence on Persistence

As we move through the beginning of the twenty-first century, one of the most prevalent issues in education is that of educating students beyond the K–12 system of education (Chang, 2002; de los Santos et al., 2006). This is particularly true for educating underrepresented students. Approximately one-third or 35% of Latina/o students who manage to complete the K–12 system of education immediately go on to college after high school graduation (Nora, 2003). Poor college participation is a major reason Latina/os are overrepresented in lower level occupations such as service workers, craftsmen, and nonfarm laborers. On the other hand, Latina/os are underrepresented in the more prestigious, higher paying jobs including technical fields, managers, and administrators (Nora). Therefore, the persistence of Latina/o students in higher education environments remains one of the most important issues related to promoting underrepresented people to the middle and upper tiers of society. To understand the entire picture of Latina/o student persistence in higher education, it is important to include pre-college experiences because what happens to Latina/os in grade school can impact college access and persistence.

The K–16 (kindergarten through college degree) educational system has long been referred to as the educational pipeline. However, Nora (2003) found that the system is more like a "seamless web with tears in the fabric" (p. 52). Using a data base representing actual enrollment figures from preschool to high school, Nora found that of the 2,856 Latina/os who enroll in preschool only 4.2% earned an associate's degree 14 years later. Of the same sample only a mere 1.6% graduated from a four-year institution. Additionally, of the total sample used by Nora, only 6% of those students who graduated from high school earned a bachelor's degree.

Educators face a future in limbo. If they work to improve the participation of minority students in science and engineering, they must first recognize the problems in our K–12 school system. The following statistics are among many that display the deficiencies in K–12 science and mathematics education:

1. In 1999, 68% of eighth graders received instruction in mathematics from a teacher who did not hold a degree or certificate in mathematics (National Center for Educational Statistics [NCES], 2004).
2. In 2000, 93% of students in grades 5–9 were taught physical science (chemistry and physics) by a teacher with no degree or certification in the physical sciences (National Center for Educational Statistics [NCES], 2004).

Additional problems in the K–12 system of education are discussed below.

Role Models

A major factor influencing children's success in education is the presence of role models (National Council of La Raza, 1998). For Latina/o students, it is particularly important for there to be a presence of Latina/o adult role models in the school and

classrooms. According to the National Council of La Raza, Latina/o teachers, personnel, and administrators serve as role models for Latina/o students. These role models can provide a vital link between the parents and the school. This is significant for Latina/o students who oftentimes have parents who lack the education to provide their children with needed guidance about educational opportunities. Additionally, the presence of Latina/o role models in schools shows non-Latina/o students that professional positions are held by all ethnic and racial groups (National Council of La Raza). It is important to note that while any qualified teacher can provide a quality education to Latina/o students, the lack of Latina/o role models in schools contributes to the failure of school systems to respond to the linguistic, cultural, and social needs of Latina/o students (National Council of La Raza). Additionally, according the NCES (1996), the proportion of minority teachers is mostly smaller than the proportion of minority students.

Deficiencies in College Preparation

Raising academic achievements in science and mathematics has been a priority of presidents and governors over the past two decades (ETS, 2003). According to the National Assessment Governing Board, in order for students to be at the proficient level in science and mathematics disciplines they must be able to analytically integrate math and science concepts into the solutions of complex problems (ETS). There is no definite way to predict that scores on the National Assessment of Educational Progress (NAEP) test are necessary to succeed in a college engineering program. However, proficiency in these disciplines is vital to succeed because of the relevance they have to engineering programs (ETS).

Hispanic students lag far behind their White and Asian student peers in the fields of science and mathematics in high school. In 2000, 20% of White twelfth graders and 34% of

Asian students scored at or above the proficient level on the NAEP assessment (ETS, 2003). In contrast, just 4% of Latina/o students scored at or above the proficient level (ETS). Educators can be sure that the small percentage of Latina/o students at the proficient level represents a formidable barrier to raising the representation of Latina/os in engineering (ETS).

Family Support

In order for a student to be successful depends highly on what the student's parents know about the college journey (Tomas Rivera Policy Institute [TRPI], 2002). Family members, especially parents, can support their child by learning to effectively utilize resources provided by the schools, counselors, and college representatives.

In a study on the barriers Latina/o students face when applying to college, Zalaquett (2006) found that 83% of his Latina/o student sample received minimal guidance from adult family members. Most of these students were first-generation students who came from families where parents had no historical knowledge about college. Moreover, the parents of these students often did not speak English and suffered from language barriers in the schools and colleges (Zalaquett, 2006). This is unfortunate because many Latina/o first-generation college students make many of the college decisions on their own, while middle- and upper-class peers have parents to help guide the college decision making process (Zalaquett).

General Factors Associated with Student Retention

A number of factors have been associated with the retention of students in higher education, and these factors are discussed below. The studies dealt with students in general, but when possible, studies specific to Latina/os are discussed.

Financial Aid

Financial aid is a major component of attending college for students who do not have enough money to afford college tuition and relative costs associated with enrollment in higher education. In 2000–2001 institutional, state, and federal sources dispersed 74 billion dollars in student aid, a 7.1% increase over the previous year (College Board, 2001). Additionally, 73% of all undergraduates received some form of financial aid (College Board). Both theory and common sense suggest that economic circumstances play a vital role in a student's retention and persistence to degree completion (Pascarella & Terenzini, 2005). Students receive aid in various forms, so it remains difficult to predict a student's success based on financial aid status alone. However, evidence is generally clear and consistent in indicating that receipt of aid in the form of grant awards, work study, and loans all reduce the economic barriers to completing a college degree (Pascarella & Terenzini).

Financial aid can have many affects on a student's retention and persistence to degree completion. In fact, many minority students have family responsibilities in the home. For instance, Nora (2003) noted that many times students must take care of family members, work full-time, and may even have children of their own. In a review of studies done of student retention and financial aid, Nora found that financial aid can reduce the stress of students and enhance their commitment to the institution providing that the institution is able to give enough financial aid to allow the student to stay enrolled in classes.

Research investigated how financial aid affects college persistence and retention on minority students. Bettinger (2004) found that Federal Pell Grant programs reduce attrition rates in college and university institutions. For higher education administrators, this information implies that federal- and state-based aid matter in higher education (Bettinger).

Minority student must be given attention because without such aid programs persistence is affected year to year (Bettinger). Additionally, studies have indicated that grant aid has a positive and significant effect on retention and persistence of undergraduate students (Pascarella & Terenzini, 2005). Specifically, minority students in engineering and technology disciplines will benefit from grant awards because they enhance the chances of a student's persistence and graduation (Fenske, Porter, & DuBrock, 2000).

Work Study

Work study is only minimally associated with college student success and persistence (Pascarella & Terenzini, 2005). Yet, in their review of recent literature in *How College Affects Students*, Pascarella and Terenzini (2005) indicated that work study is positively associated with student success. However, further research is required to get more conclusive results. Work study most importantly gives students a chance to academically and socially integrate into the institution through interactions with faculty, staff, and administrators (Pascarella & Terenzini).

Student Financial Aid Loans

Literature on the importance of loans has mixed results. Research has shown that loans have both negative and positive effects on student retention and persistence (Pascarella & Terenzini, 2005). Therefore, any conclusions regarding the effects of debt accumulation through student loans must await replications of these findings (Pascarella & Terenzini). Studies on financial aid and the effects on student retention and persistence vary in their conclusions. However, financial aid can either reduce or eliminate obstacles to accessing a higher education degree. Aided students, no matter what demographics and characteristics, are just as likely as unaided students to persist and graduate from an institution of higher

education (Pascarella & Terenzini). Therefore, aiding students levels the playing field concerning college access for underrepresented people.

Campus Climate

The factors that influence Latina/o students' experience and retention in college can vary from place to place. Accordingly, understanding the campus' racial and ethnic makeup is vital when looking at what makes a student succeed and remain persistent in their particular educational environment (Swail, Redd, & Perna, 2004). Obstacles to a Latina/o student's persistence include racism, discrimination, hostility, self-doubt, negative stereotypes, and alienation (Swail et al., 2004). These obstacles can be especially harsh at predominantly-white institutions (PWIs) like ISU. This potentially cold environment calls for higher education administrators to be particularly mindful of student needs when considering retention and validation of Latina/o students.

In higher education research, the campus climate has been defined as the current perceptions, attitudes, and expectations that define the institution and its members (Peterson & Spencer, 1990). Research over the years has begun to provide important guidance in understanding how to achieve diversity while improving the learning environments for students from different racial/ethnic backgrounds (Hurtado, Milem, Clayton-Pedersen, & Allen, 1999). One step in improving the learning environment lies in understanding and developing programs and policies that improve the campus climate for groups such as those who represent racial/ethnic minorities. According to Hurtado et al. (1999), this step towards creating more diverse learning environments involves institutional agents understanding the campus climate from the perspectives of the individual members who represent racial/ethnic minorities in the college.

Overall, the literature reveals how the different, interrelated aspects of the climate for diversity are linked with a broad range of educational outcomes for diverse groups of students (Hurtado et al., 1999). An important belief underlying this conceptualization of the climate for diversity is that diverse racial/ethnic groups often view the campus in a different way, and each concept is legitimate because it has real consequences for the person (Astin, 1968; Tierney, 1987). Research showed that increasing the racial/ethnic diversity on a campus while neglecting to attend to the racial environment can result in challenges for students of color. Research has recognized how various racial/ethnic groups can experience difficulty as a result of a poor racial environment. This research showed that individuals' and particular groups' perceptions of the environment are not insignificant or insubstantial but have tangible and real effects on the transition to college and on educational outcomes of minority college students (Hurtado et al.).

Alienation

Acland and Azmi (1998), in studying the experiences of minority students in higher education institutions, found that students of color were dissatisfied with the lack of students from diverse backgrounds. Also, the lack of diverse faculty and staff added to their dissatisfaction, making it difficult for students to adjust to life away from home and to cope with the impersonality of studying in a large institution. One student, according to Acland and Azmi (1998), stated that "staff need training on how to treat ethnic minority students" (p. 81). In addition to alienation, students in this study claimed that cliques of white students dominated social activities in the university. Furthermore, Acland and Azmi found that students gained support through cultural clubs and organizations as such social interaction allowed for friends and support groups that addressed their needs. It is important to note that

students found these social groups more effective than the formal institutional support offered by university personnel.

Experiences that Foster Success for Latina/os in Engineering

Hispanics are the least formally educated population in the United States because they have such high attrition rates in high school and are consequently less likely to attend college (Brown, 2002; Gandara, 1995). For example, in California and Texas where more than a third of the population is Hispanic, only 11–13% are enrolled in four-year colleges and universities (Gandara, 1995). With such high Hispanic attrition rates it is no surprise that there is a significant lack of representation in science and engineering college programs. In fact, very little research is available to explain the causes that affect retention and persistence in engineering fields.

Strategies for Recruitment and Retention

Many universities have special recruitment offices and programs for engineering. Simply having such programs available can be counterproductive if all efforts focus on access to the university for Latina/os with no real retention program in addition to the recruitment efforts (Seymour & Hewitt, 1997). Research also suggested that when special retention programs are made available to all students, they reduce stigmatizing Latina/os and other minorities who gain social and academic skills from the special programs which strive to integrate all students together as one community. Remedial education and special population programs have many benefits, but remedial education has both critics and proponents. Critics argue that remedial education can sometimes hinder the self confidence of underrepresented students by singling them out from their white counterparts, while proponents of the program speak of its ability to bring students from resource-poor K–12

education systems to an even playing field with students who come from schools with high achievement (NCES, 2000; Seymour & Hewitt, 2000; Sorensen, 2000).

Serving as Mentor or Tutor

For an engineering student to serve as a mentor or tutor for pre-engineering majors or newly enrolled engineering majors was found to have positive effects on the mentor's or tutor's retention and persistence (Good, Halpin, & Halpin, 1998). Having mentor programs greatly helped new students integrate into the university environment along with giving upper-class students the opportunity to share gained knowledge and experiences as a Latina/o student in engineering (Good et al.). Such programs can help the mentor and protégé affect the over all retention and persistence in engineering. Without such affirming experiences in traditional engineering programs, student success can be compromised not just for Latina/os, but all minorities (Chang, 2002).

Pedagogical Strategies

Females and students of color have long been underrepresented in the fields of science and engineering at U.S. colleges and universities. Engineering courses are predominantly traditional in the pedagogy employed by engineering faculty which can hinder the integration of Latina/o students in engineering programs. Traditional pedagogy in engineering disciplines has meant having a method of teaching that prefers competitive and fact-based strategies of inquiry (Tsang, 2000). This quantitative method of inquiry is then demonstrated in the professor's teaching style and projected onto the students (Tsang). Brown (2002) found that when science and engineering is taught in the traditional manner, the science, engineering, and math routes seem to be closed to students of color. This can have detrimental effects on the students' retention and persistence. It is imperative that

educators make changes so that all routes are accessible to all students to investigate and learn as they maneuver the educational journeys of their lives (Brown).

Academic and classroom retention factors are difficult to measure in a post-secondary institution but may have a substantial influence on students of color, especially African-Americans and Hispanics (NCES, 2000). Research indicated that the manner in which engineering content is introduced to students as highly competitive, quantitative, and lecture in format, is inherently disadvantageous for underrepresented populations (Brown, 2001; Seymour & Hewitt, 1997). Research also indicated that attitudinal factors contribute to the discrepancy in cultural values and STEM fields. African-Americans, Native Americans, and Latina/os possess strong cultural values of group and community membership that may be at odds with the perceived levels of individualism and competition associated with the sciences (NCES, 1996). Latina/os also report a lack of interaction with current participants in science and engineering fields which can represent a barrier to increased interest and persistence in engineering (Chang, 2002).

Retaining Latina/os in engineering may be as simple as changing the way faculty approach the teaching of engineering and technology. In fact, designing an inclusive curriculum which values diverse learning styles and is attentive and responsive to diverse cultural orientations can also be a motivator when introducing technology (Brown, 2001). Many minority students are drawn to service oriented careers that give back to the communities from which they came. Therefore, introducing technology and engineering disciplines with cultural values in mind may help students of color remain motivated to stay enrolled in engineering professions (Brown, 2001; NCES, 2000). In his article titled

Service-Learning as a Pedagogy for Engineering, Edmund Tsang (2000) noted that the key reason engineering is taught in lecture and competitive formats is because engineers lack the interest in reflective learning. Reflective learning is a vital component to service-learning pedagogy. Jacoby (1996) defined reflective learning as "learning about the larger social issues behind the needs to which their service is responding. This learning includes a deeper understanding of the historical, sociological, cultural, economic, and political contexts of the needs or issues being addressed" (p. 7).

Additionally, Latina/os may be ill-equipped for the rigorous academic demands of the engineering curriculum (Sorensen, 2000). This is demonstrated by the increase in student enrollment in remedial mathematics education (NSB, 2002). However, these classes are vital if institutions of higher education are to respond to Latina/o students' lack of preparedness due to the education they receive in poorly funded schools and low performing high schools (Chang, 2002). Furthermore, research has indicated that if higher education institutions are to increase retention of Latina/os and all students of color, such remediation is needed and important for future engineers (Chang).

Theoretical Framework

For the purposes of studying Latina/o student persistence in the College of Engineering at ISU, I will employ Rendón's (1994) validation theory and Nora's (2003) Model of Student Engagement.

Validation Theory

Rendón defined validation as "an enabling, confirming and supportive process initiated by in- and out-of-class agents that foster academic and interpersonal development" (1994, p. 44). There are two types of validation in Rendón's model. The first, academic

validation occurs when in- and out-of-class agents take action to increase the student's learning capabilities and confidence as a college student. The second, interpersonal validation, arises when in- and out-of-class agents take strides to help students increase their personal development and adjust to their new social environment (Rendón). The theory of validation (Rendón) has six elements which fit well when studying Latina/o students in higher education. The first element places the burden and responsibility for initiating contact with students on institutional agents such as professors and counselors. Many times, according to Rendón, students from lower socioeconomic backgrounds are hesitant to ask for assistance and guidance because of their past experiences with having been treated as incapable and unfamiliar with the higher education system. Second is the idea that when validation is present, students feel proficient enough to learn as well as develop a sense of self-worth. Third is the notion that validation may be a prerequisite to student development. Rendón stated that students are more likely to become engaged with their university's environment if academic and interpersonal validation is offered on a consistent basis. Fourth is that validation for a student can occur in and out of a classroom. Individuals such as faculty, counselors, coaches, spouses, and children often support students and promote academic excellence and personal growth (Rendón). The fifth element of the Rendón's theory is that validation is a developmental process as opposed to an end resulting in a final outcome of working with students. According to Rendón, many instances of validation throughout the college experience can result in a more fruitful academic and personal experience. Finally, the sixth element of Rendón's model is the importance of offering validation. This is especially important throughout the first year of college and during the first weeks of a new student's first academic term.

Validation theory (Rendón, 1994) recognizes the inevitable limitations of expecting all new students to become involved in their college community regardless of their background or socioeconomic status. In the validation model, institutional agents, not students, are expected to take responsibility and communicate to students that they are capable learners and valuable members of the university learning environment. Additionally, validation theory insists that college faculty and administrative staffs take active roles in reaching out to students to reassure their role as students and to support students in their new academic and social changes. Finally, Rendón (2002) makes it clear that there are many differences between traditional and nontraditional students, and that it is vital for institutional agents to distinguish between the two types.

Nora's Model of Student Engagement

Nora's (2003) Model of Student Engagement addressed the pre-college and in-college factors that affect Latina/o student persistence to degree completion. Using existing theories Nora devised a model consisting of six major components (Table 2.1): (a) pre-college/pull factors, (b) sense of purpose and institutional allegiance, (d) academic and social experiences, (e) cognitive and noncognitive outcomes, (f) goal determination/institutional allegiance, and (g) persistence (Nora, 2003).

Pre-college/Pull-factors

The first component of the model addressed the pre-college preparation and pull-factors that deter students from higher education. The academic ability of students in high school academics will help or hinder students' persistence later on in college. Additionally, in the first component the student's engagement in high school and the activities they participate in will likely determine their educational aspirations long before the

college selection process. Financial assistance is a major factor for Latina/o students when considering a college education. Financial aid is a way to even students out financially in order to reduce or eliminate financial barriers to higher education (Nora, 2003). Family support is also vital in the future persistence of a high school student headed for college. Parental encouragement and support extract a positive effect on a student's initial interest in college and integration into the college environment as well as the student's commitment and decision to remain enrolled in college (Nora & Cabrera, 1996).

Sense of Purpose and Institutional Allegiance

The second component of the model addresses the student's initial commitment to attend a specific institution. Allegiance to a specific school will improve the chances of retaining a student once they enroll in college (Nora, 2003). Supportive evidence of this positive influence includes past studies (Nora) which all found that the student's commitment to an institution put forth a positive effect on the student's decision to remain enrolled in college level education (Nora).

Academic and Social Experiences

Academic and social experiences have been the focus of many higher education administrators because they seem to be the most influential on the persistence and retention of Latina/o students. Academic experiences include both formal and informal interaction with faculty and campus leaders. Faculty can also have enormous influence on a student through mentoring and validation in and out of the classroom. These interactions in the academic climate exert a positive association between the student and the institution. Social experiences include peer group interactions, perceptions of prejudice/discrimination, and encouragement and support from staff and fellow students. Perceptions of prejudice and

discrimination are easily sensed by Latina/o students in the classroom and on campus (Nora & Cabrera, 1996). Consequently, these social experiences affect their academic performance, experiences with faculty, and intellectual development.

Cognitive and Noncognitive Outcomes

Cognitive factors affect persistence and include educational grade point averages (GPAs) and the development of students to recognize their actual intellectual gains and perceived gains while in college (Nora, 2003). Noncognitive gains include a greater appreciation for the fine arts, valuing diversity, and greater self-esteem. All of the above mentioned cognitive and noncognitive factors influence whether or not a student remains committed to the university which leads to reenrollment and persistence to graduation (Nora).

Goal Determination/Institutional Allegiance and Persistence

Goal determination/institutional allegiance relates to the extent students are determined to attain future goals which may include going to graduate/professional school. Allegiance to the institution refers to the student's perceived sense of belonging and whether the college experience has been worthwhile and meaningful (Nora, 2003).

Finally, the five components of Nora's model are related in some way to lead to the final component of persistence. Persistence refers to whether the university is successful in creating a space where the student feels passionate enough about their education to reenroll in the institution of higher education.

Table 2.1

Nora's (2003) Model of Student Engagement

Pre-college and Pull-factors	**1. High school academic ability** **2. High school and home environment** **3. Tangible or intangible financial need** **4. Family support and family responsibilities**
Sense of Purpose and Institutional Allegiance	**1.Educational aspirations and commitment to attending a specific institution**
Academic and Social Experiences	**1.Formal and informal interactions with faculty** **2.In- and out- of classroom experiences** **3.Social group interactions, involvement in organizations** **4.Campus climate and tolerance versus acceptance** **5.Validating experiences** **6.Faculty mentors, and counseling**
Cognitive and Non-Cognitive Outcomes	**1.Grade point average (GPA)** **2.Academic and intellectual development** **3.Non-cognitive gains including appreciation of the arts, self-esteem, and valuing diversity**
Goal Determination	**1.Degree attainment** **2.Educational goals beyond college**
Persistence	**1.Re-enrollment in higher education institution**

Note **. Nora, A. (2003)**

Summary

This literature review addressed three areas relevant to the investigation of Latina/o student persistence in engineering programs (K–12 influence on persistence, general factors associated with the retention of Latina/os in higher education, and experiences that foster

success for Latina/os in engineering). Together, all three areas play a vital role in whether a student decides to stay or leave the institution of higher education or change their academic objective altogether. Strategies like special programs for recruitment and retention can help underrepresented students feel validated and equal to their peers. Furthermore, the campus climate must be a place conducive to inclusion and support. Only when institutional agents (i.e., faculty, counselors, and administrators) decide to address retention and attrition issues in the college learning community can change positively take place.

Finally, this investigation of Latina/o student persistence in engineering majors is guided by two theoretical frameworks. The first is Rendón's (1994) validation theory which posits the importance of academic and interpersonal validation especially for low-income, first-generation students. The second is Nora's (2003) Model of Student Engagement which synthesizes existing research to identify the major factors that influence the persistence of Latina/o students in higher education. Nora's model is inclusive because it looks at both the pre-college and college factors that eventually link to a student's overall persistence and retention in an institution of higher education.

CHAPTER 3. RESEARCH DESIGN

Introduction

To investigate the persistence of Latina/o students enrolled in engineering fields of study at ISU, a qualitative research design was employed. Qualitative research was utilized to bring the voice of Latina/o students to life given that much of the current literature is quantitative in nature. Through the use of a phenomenological methodology, the researcher obtained accounts of student experiences in engineering programs in the students' own voices. Phenomenological methodology involves studying small groups of subjects through extensive engagement to develop concepts of meaning in order to understand the lived experiences of others (Moustakas, 1994). Understanding who or what was making a difference, obstacles encountered, and the students' views of the experience can help to inform university faculty and administrators of the particular experiences these students underwent while attempting to earn an engineering degree. Specifically, this study employed focus group interviews as the main method of data collection. The goal of collecting this type of data was to analyze and adapt themes and concepts which would then explain the academic and social experiences that affect persistence of Latina/o students. Additionally, a survey instrument was used in this study in order to collect demographic information on each participant. This survey was descriptive and provided a profile of the Latina/o student respondents who volunteered to participate in this study.

Rationale for Qualitative Research Design

Qualitative research has a long history in anthropology and sociology. It is no longer limited to these disciplines and has become an accepted method of inquiry in the social sciences and education disciplines (Merriam, 2002). Denzin and Lincoln (2005) made it clear

that qualitative research belongs to no single discipline. Thus, qualitative research uses a wide array of methods that are not distinctly its own in studying social phenomenon. Qualitative inquiry is especially useful in understanding human experience, as it allows the perspective and voice of the participants to be explored and understood.

Methodology

The research presented in this investigation of Latina/o student persistence is informed by a phenomenological stance. Phenomenology seeks to understand the essence of human experiences (Jones, Torres, & Arminio, 2006; Moustakas, 1994). Specifically, in this study the phenomenon being examined was how Latina/o engineering students experience persistence in the College of Engineering. From the phenomenological perspective the researcher seeks to understand how a social world is made meaningful to an individual through personal experiences (Denzin & Lincoln, 2005). The researcher's focus is on how respondents act upon their experiences as if they are separate from the person's self (Denzin & Lincoln). According to Merriam (2002), phenomenology is a twentieth century school of philosophy associated with the German philosopher Edmund Husserl. Although all qualitative research is somewhat phenomenological in nature, phenomenology specifically seeks to understand the fundamental nature, or core, of a phenomenon (Merriam). Moreover, phenomenology focuses on the ordinary experiences of individuals and on generating thick description out of those experiences (Jones et al.). Phenomenological investigation is usually conducted with small groups of people to allow for relationship building; therefore, a small group of participants are cast in this study. Phenomenological inquiry asserts that phenomenological description is only a single description and no one interpretation of human understanding can exhaust other forms of experience (Jones et al.). Finally, the data analysis

employed an inductive position where a conceptual framework, model, or theory could be grounded in the raw data of the present study (Glaser & Straus, 1968; Thomas, 2003).

Procedures

The data for this study were collected using two different instruments. First, a survey instrument was utilized in order to collect data on student characteristics. Second, focus group interviews were employed to collect the primary data needed to answer the research questions. Data collection took place at ISU with self-identified Latina/o student engineering majors.

Research Site

The site for this study was at the College of Engineering at ISU in Ames, Iowa, in the United States. ISU is a large public land-grant university with approximately 25,000 students (Iowa State University Office of Institutional Research, 2006). The university has eight academic colleges with 54 academic departments. In 2005 the university awarded 4,679 bachelor's degrees.

In the College of Engineering, 4,551 students were enrolled in classes in 2005 (Iowa State University Office of Institutional Research, 2006). The college offers 10 different engineering concentrations including agricultural/biosystems engineering, mechanical engineering, and aerospace engineering. Additionally, Latina/os made up 2.8% of the undergraduate population in the engineering college. Each focus group interview was conducted in a classroom within the College of Engineering free from noise and distractions.

Participants

This study did not use random selection. Participants were purposefully selected based on their self-identification as Latina/o engineering undergraduate majors at ISU.

Purposeful sampling allowed the researcher to select participants with relevant experiences that are permissible for the best possible data to be collected (Esterberg, 2002). The respondents had no relationship with the researcher. All participants were made clearly aware of the reasons and purpose of this study. To ensure participant safety, informed consent was obtained from each individual participant to ensure his or her willingness to participate. The researcher recruited participants at the ISU campus through the use of a database obtained from the Office of the Registrar at ISU. In this database the researcher was provided with the name and contact information for each Latina/o student registered in engineering classes at ISU during the spring 2007 semester. Additional information such as email address, class level, and racial/ethnic identity was also provided in the database. Each individual participant was initially contacted by the researcher through email correspondence. Students interested in participating were then added to a contact list and scheduled for one of four focus groups. Further participant recruitment took place in the form of two presentations made at meetings of the ISU chapter of the Society of Hispanic Professional Engineers (SHPE). At this meeting the students were informed of the research and invited to participate. A detailed presentation of the participant sample in this study is provided in chapter 4.

Survey Instrument

A survey was developed to gather descriptive data needed to generate a profile of Latina/o engineering majors at ISU. The survey instrument was administered to each participant who attended any one of the four focus group interviews. The survey was descriptive and used only for the purpose of describing the characteristics of this study's sample as accurately as possible.

Rationale for Survey Instrument

In order to develop the survey, a thorough review of existing surveys aimed at measuring Latina/o student demographics was conducted. Rendón and Nora's (2004) student retention survey provided a reference for the development of survey questions. The survey addressed simple closed-ended questions (i.e., socioeconomic status, major, G.P.A, etc.), which related to the open-ended focus group interview questions (i.e., academic and social experiences, impressions of ISU community, etc.) to ensure that time during the focus group was spent exploring the experiences of Latina/o student engineers at ISU. This straightforward survey allowed for the best possible data to be collected and analyzed from the focus group interviews.

Description of Survey Instrument

The entire survey instrument's contents are made available in Appendix B of this study. Questions on the survey were divided into four different sections: (a) demographics, (b) pre-college experiences, (c) family and lifestyle, and (d) college experiences at ISU. A brief description of each section is provided.

Demographics. Section one of the survey addressed the personal demographics and characteristics of each individual participant. This section included questions which attended to the students' gender, specific race/ethnicity, socioeconomic status (SES), ISU major, academic classification, and student transfer status.

Pre-college experiences. Section two of the survey addressed each individual student's experience before entering college. These questions elicited responses related to the student's high school science and mathematics preparation, high school GPA, reasons for

choosing ISU, and perceptions of how well the student thought he/she was prepared to study engineering in college.

Family and lifestyle. Section three of the survey instrument asked questions which would shed light on a student's family experiences and lifestyle. Questions in this section of the survey asked about family support for pursuing a college education, family financial support, family responsibilities (i.e., working, taking care of family members), financial aid utilization, and generational status.

College experiences at ISU. The last section of the survey instrument dealt with the experiences of each participant as a student at ISU. This section of the survey sought to gain information on the student's ISU GPA, likelihood of finishing a college degree, likelihood of switching to a major outside of the College of Engineering, sense of belonging to the ISU community, and how long it would take to finish his/her college degree.

Pilot Study

A pilot study was administered in order to test the survey instrument for clarity and time needed for students to fully complete the survey. The researcher asked five student peers to voluntarily participate in a mock focus group with the goal being to administer the survey and work out any possible logistical set-backs and/or threats to the survey instrument's trustworthiness. Minor changes were made to the survey questions in order to ensure clarity. From the pilot study, 10 minutes was determined to be adequate time for participants to fully complete the survey instrument, which was administered at the beginning of each focus group interview.

Trustworthiness of Survey Instrument

A pilot study, a review of existing related surveys, and faculty consultation with the researcher helped to minimize and/or reduce threats to the survey's trustworthiness. Essentially, trustworthiness determines whether the data collection instrument is appropriate in measuring the phenomenon under investigation. Threats to the survey's trustworthiness included unclear questions and improper organization of questions. The survey employed in this study used survey instruments employed in past studies as a reference point. Rendón and Nora's (2004) student retention survey was a main source of reference and provided a foundation for the development of the survey instrument used in this study. It was determined that the survey instrument was a trustworthy measure of participant characteristics.

Survey Data Analysis

Once all focus group interviews were complete and surveys were administered to each participant, an analysis was conducted using the *Statistical Package for the Social Sciences* (SPSS). Data from each survey were entered into the SPSS software, and descriptive statistics were calculated. Each survey question was then analyzed along with the percentage of participants who selected specific answers for each survey question. These results were then analyzed in order to develop a profile of the sample represented in this study.

Focus Group Interviews

This study employed a focus group method of data collection. By definition, a focus group is a purposely designed group which seeks to understand and yield data on how people feel or think about specific issues or ideas (Krueger & Casey, 2000). According to Krueger

and Casey, a focus group is not just getting a small cohort of people together for specific discussion. A focus group is a specialized and focused assembly because it has a specific purpose, size, composition, and procedure. Focus group research has become a more popular research approach in recent years and is traditionally used in academic and business marketing research. Furthermore, focus groups allow participants to answer and respond to questions in a group setting that allows the respondents to express their views and opinions in a safe and open environment (Krueger & Casey). This method of data collection can provide rich qualitative data, and that is a key reason for its employment in this investigation of Latina/o student persistence in engineering fields of study. According to Krueger and Casey, focus groups typically elicit a range of opinions of people across several groups. The data are then compared between various groups to then construct results and concepts of the data. Finally, utilizing focus groups as the method of data collection provides a more natural setting where respondents can build upon each other's responses, leaving the researcher to allow the group discussion to happen naturally and free of structured and formal questions most often utilized in individual one-on-one interviews (Krueger & Casey). Interviewing students in groups allowed the researcher to interact with students and prompt them for specific information. The human voice of Latina/o engineering students is significant because it provides the individual perspectives of students who experience engineering programs at ISU, a predominantly white institution. Student experiences can provide important themes in understanding why Latina/o students elect to stay or leave their engineering program.

Focus Group Interview Protocol

The main source of data collected for this study came from four focus group interviews. Focus group interviews were administered using an interview protocol with eight questions. The focus group interview protocol is presented in its entirety in Appendix A.

Rationale for use of interview protocol. The focus group interview protocol was developed to ensure that research questions would be addressed in the data collection phase of this study. The interview protocol served as a guide for the researcher during interview sessions. The protocol helped ensure that all groups were asked the same questions in order to elicit relevant responses. Additionally, the interview protocol allowed the researcher to limit his voice during the session by only asking the protocol questions and follow-up prompts, which kept the participant voice active during each focus group interview.

Development and Description of Interview Protocol

The focus group interview protocol was created utilizing existing resources as a framework for development. The researcher utilized Nora's (2003) Model of Student Engagement to guide the development of the interview protocol. Nora's model allowed the researcher to formulate questions based off of the factors identified by Nora that affect Latina/o student persistence. Therefore, the interview protocol focused on the topics outlined in Nora's model such as pre-college experiences, college academic and social experiences, and perceived cognitive and noncognitive academic gains. The first two questions in the interview protocol addressed the experiences of Latino engineering students prior to matriculating into ISU. Questions three through six of the interview protocol addressed the experiences of Latino students in the College of Engineering. Specifically, these questions asked for responses regarding both academic and social experiences. Finally, the remaining

questions addressed the perceived cognitive and noncognitive gains of the students. Raw data on students' cognitive and noncognitive academic gains, however, were not used in this study and are explained below.

Pilot Study

The focus group interview protocol was subjected to review by the use of a pilot study and approval from the researcher's faculty advisers. A pilot study using the interview protocol was conducted with five student peers of the researcher. The purpose of this pilot study was to introduce the data collection instruments (e.g., focus group interview questions) to individuals with no relation to this study. The interview protocol was presented to the pilot study participants just as the researcher planned to administer the questions in actual focus group interviews. After the pilot study, peer participants offered suggestions to clarify minor parts of the interview protocol questions. It was concluded that the interview questions contained in the protocol were clear enough to employ during the data collection of this study.

Trustworthiness of Interview Protocol

The pilot study, review of similar interview protocols employed in other studies, and faculty review of the interview protocol allowed the researcher to ensure that the interview protocol was a trustworthy instrument. Threats to the protocol's trustworthiness were unclear or irrelevant questions contained within the interview protocol. Joseph Saggio's (2000) dissertation focus group interview protocol and Nora's (2003) Model of Student Engagement were both employed as a reference in this study to develop the interview protocol. Saggio's dissertation used a similar interview protocol to investigate retention of American Indian students in a Bible college, and Nora's Model of Student Engagement examined the retention

and persistence of Latina/os in higher education. It was determined that the interview protocol was a trustworthy data collection instrument.

Focus Group Data Analysis

Focus group interview data were analyzed by the researcher after the completion of all data collection. In qualitative research, data analysis is the process of making meaning. It is not mechanical and gives focus to a creative process (Esterberg, 2002). This analysis is grounded in phenomenological research. Moustakas (1994) described phenomenological research analysis as analyzing specific statements resulting in a description which encompasses the spirit of the participants' experiences. Thus, the results of this study shed light on the experiences of individuals who represent a specific population of students.

This study made use of transcript-based analysis since this type of process is the most rigorous approach used to analyze transcript data (Krueger & Casey, 2000). In transcript-based analysis, a complete transcript of the focus group discussion is made. Each focus group's audio recordings were transcribed by the researcher after all focus groups were completed. The transcripts were transcribed using a *Microsoft Word* document with all participant identifiers removed for confidentiality. Each participant was referred to as either a male or female participant in the transcripts. The author then used a coding method of analysis to extract themes and concepts from the data, which then allowed for the results of this study to be finalized. Creswell (2003) defined the coding method as "the process of organizing material into chunks before bringing meaning to those chunks" (p.192).

Phases of data analysis. The first phase of analysis consisted of reviewing each audio recording from each focus group and taking thorough field notes throughout the data collection and data analysis phases of this study. These field notes allowed the researcher to

document information such as the participants' mannerisms, body language, emerging themes and categories, and the overall impressions of the group. Following the initial review of data, complete and unabridged transcripts were made from each audio recording by the researcher. Every spoken word was transcribed with exceptions given to confidentiality. Specifically, only two names were omitted from the original transcripts because a participant explicitly identified her conflict with a professor and specific names of each person were spoken during the focus group interview.

The second stage of analysis consisted of reading each transcript individually. During this process keywords were written into the margin of each transcript based off the participants' responses during focus group interviews. The researcher also made use of journaling thoughts and initial analysis of the data collection during this step. The journals helped the researcher to better recognize and develop preliminary concepts buried in the data. This process continued throughout the data analysis of this study. According to Creswell (2003), this stage of the analysis should be an ongoing process which involves asking questions, reflection, and continual writing.

The third phase of analysis consisted of an additional review of each transcript, employing a coding process. This phase involved arranging the responses of the focus group members into categories in order to group similar responses. This sorting and development of sorted questions and responses helped to analyze concentrated responses to questions in order to gain a deeper understanding of the participants' voices. After the data were categorized, all data were then reviewed once more using various color highlighters to categorize and make note of specific responses which spoke to the emerging themes revealed during coding

analysis. Additionally, journal entries were used once again to organize and begin development of themes for written discussion in the results chapter of this study.

Once initial categories of results from data collection were developed, the researcher presented the results to his faculty adviser for review and discussion in the fourth phase of analysis. A formal write-up of the results took place and then was presented once again to the researcher's faculty adviser for review. The results were then presented to the researcher's thesis committee for examination. Furthermore, the researcher solicited suggestions and feedback from faculty advisers, and minor changes were made to the results and findings so as not to affect the voice or content of the student participants portrayed in this investigation.

Excluding certain data. During this investigation, data were collected that attempted to explain the perceived cognitive and noncognitive gains in the students' education. However, the focus group interviews failed to yield solid dialogue which could be analyzed for themes and concepts about cognitive and noncognitive gains. Therefore, during the data analysis phase, data on student's perceived cognitive and noncognitive gains were removed from the study.

Strengths of the Study

In this study, the questions used in the interview protocol were developed and finalized in consultation with the researcher's thesis committee. Screening interview questions ensured that the interview protocol was trustworthy and not culturally offensive. To ensure that the instruments were trustworthy, a pilot study was conducted with students who had no relation to the topic or problem addressed in this study of Latina/o Student persistence.

A second strength of this study was that effective safeguards were included in the research design to ensure that an accurate understanding and portrayal of the participants' voice was reached. For example, the researcher listened to the focus group audio recording and took extensive field notes immediately after each focus group. Additional listening sessions of the focus group data were conducted and then noted in the researcher's field notes before any thorough analysis commenced. Furthermore, the researcher sought professional consultation with his faculty advisers to ensure that the initial understandings of data were clarified.

A final strength of the study was the researcher's intention to conduct the focus group interviews in the engineering environment. All focus groups took place in a closed engineering classroom free of visual and noise distractions. This ensured that the student participants were in their learning environment to guarantee that genuine dialogue about engineering experiences took place.

Ethical Concerns

The researcher was affiliated with ISU as a full-time graduate student enrolled in the Educational Leadership and Policy Studies department in the College of Human Sciences. During the academic year of 2005–2006, the researcher was employed in the Office of Outreach and Recruitment in the College of Engineering. This resulted in the researcher having worked with one of the participants in a professional capacity to coordinate a campus event in the fall of 2005.

Informed consent was signed by each participant before taking part in this study. The ISU Internal Review Board (IRB) approved the use of human subjects in this investigation. No participants were compensated for their time; they were invited to discuss any risks or

benefits of participating in this study with the researcher. All documents on participant identification were removed from any prepared materials related to this study, and confidentiality was maintained at all times. At the conclusion of this study all documentation and audio recordings kept on the participants were destroyed.

Finally, the faculty advisers of the researcher were properly informed of all stages of the research process and had the right to monitor the process of this study if necessary. Overall, the ethical concerns were limited in this study, and all student participants took part willfully and free of harm to themselves or others.

Summary

In summary, a qualitative methodology was used in this study of Latina/o student persistence in engineering fields of study. Additionally, a descriptive survey was utilized to develop a profile of Latina/o engineering majors at ISU. Specifically, this study used focus groups as the main method of collecting data which yielded themes and concepts for the investigation of why Latina/o students elect to stay or leave their engineering program at ISU. In light of the prestigious reputation of the College of Engineering at ISU, the college still fails to retain Latina/o students to graduation. This is evident in its alarmingly low graduation rates which have remained below 2% from 2003–2006 (Iowa State University Engineering Office of Graduate Studies, 2006a). Accordingly, the research questions contained in this study warrant great significance because they allow for a deeper understanding of how Latina/o students experience persistence in engineering fields of study. Data were then analyzed using a transcript-based analysis which employed an open coding process to arrive at final themes and concepts derived from the focus group sessions.

Strengths of this research include the data collection methods which were tested for trustworthiness. Ethical concerns were limited by ensuring that the researcher had no relationship with the participants and guaranteeing the confidentiality of participants' identities. Information was kept off the record at all times. The next chapter presents this study's findings which include the Latina/o student profile and the major themes and concepts derived from the transcript-based data analysis of focus group interviews.

CHAPTER 4. RESEARCH FINDINGS

Introduction

The results of this investigation give educational leaders and scholars a glimpse into the experiences of Latina/o students in the College of Engineering at ISU. This chapter presents the study's findings which employed two methods of data collection—survey and focus groups. Survey data provided a profile of Latina/o students at ISU who major in engineering fields of study. Data from focus groups provided concepts and themes that illustrate the social and academic experiences of Latina/o student engineers as they navigated the engineering undergraduate experience. In addition, focus group interview data illustrated how students were prepared for and made choices to attend ISU and persist.

Profile of Latina/o Student Engineers at ISU

Prior to engaging in the focus group dialogue, study participants were asked to complete a descriptive survey that provided demographic and background information. All respondents identified as Latina/o/Hispanic. The terms Latina/o and Hispanic are umbrella terms capturing various races, ethnicities, nationalities, and cultures. The next section highlights the profile of Latina/o students at ISU. Tables 4.1 and 4.2 illustrate information gained from the survey data collected. Specifically, Table 4.1 provides demographic information of student respondents, and Table 4.2 showcases participants' educational data.

Gender, Race/Ethnicity, and Generational Status

The sample of 13 Latina/os consisted of seven female students and four students identified as first-generation college students. This sample represented 15% of the total Latina/o engineering student population at ISU and consisted primarily of Mexican/ Mexican-American (seven students) and Puerto Rican (three students). The remaining

respondents identified some other Latina/o/Hispanic national origin. Interestingly, a majority of the students chose to identify their national origin in the "other" category on the survey questions asking for racial/ethnic identity (see Table 4.1).

Socioeconomic Status (SES)

Socioeconomic status refers to the income level and educational attainment of a student or family. Twelve students stated that they personally earned less than $40,000 per year. This suggested that these students might be financially supported through external sources such as family financial support, as well as loans and scholarships. Six students came from families who earned less than $40,000 per year, while the remaining respondents came from families who earned more than $40,001 per year. Overall, this data illustrated that the majority of respondents were from middle- to upper-class families.

Parental educational attainment data were collected from the survey. Four of the 13 mothers did not finish high school, and six of the mothers completed some form of college education ranging from associate's degrees to master's degrees. As for the educational attainment of the 13 fathers, four did not graduate from high school, while six fathers completed some form of college ranging from associate's degrees to doctoral degrees. Table 4.1 contains the demographic information for each respondent including the SES.

High School Academic Preparedness

Overall, the respondents were well prepared for success in engineering at ISU based on their high school academic preparation in science and mathematics. In fact, 11 students had a high school grade point average above 3.5. Eight respondents had high school GPA's between 3.8 and 4.0. Their science preparation was beyond the minimum needed for admission to ISU. ISU admission requirements state that all students must successfully

complete three or more high school science classes. Of the sample, two students completed three years of high school science, while the remaining respondents each completed more than four high school science classes. Math preparation also exceeded minimum requirements. ISU admission requirements state that all entering students must successfully complete at least three high school level math classes. Of the sample, three students took three high school math classes, while the remaining respondents each took more than four high school math classes. This demonstrated that the Latina/o respondents were qualified and prepared for the engineering curriculum according to ISU standards. Interestingly, when asked whether students felt prepared for their engineering education, three students stated that they were underprepared, while five respondents stated that they were well prepared to study engineering at the college level. The data indicated that Latina/o students generally perceived their level of high school preparation to be adequate.

Enrollment and Transfer Status

All student participants were enrolled as full-time undergraduate engineering majors at ISU during the spring semester of 2007. Two students had transferred to ISU, and 11 participants began their college education as first-year students at ISU. The majority of respondents (four students) majored in mechanical engineering. Remaining respondents majored in chemical and biological engineering, computer engineering, civil/environmental engineering, and aerospace engineering. Table 4.2 lists all educational data for each individual participant.

Academic Status

The sample of Latina/o student engineers was diverse along academic class rank (see Table 4.2). Five students were first-year students/freshmen, two students were sophomores,

three students were juniors, and three students were seniors. Academic GPA for Latina/os was average. The majority of students (seven students) held ISU grade point averages between 2.5 and 3.0, while five students held grade point averages above 3.0. This is significantly lower than their high school grade point averages, but may still be considered as success in a demanding engineering curriculum at the college level. These educational data are displayed in Table 4.2 along with the academic status of each participant.

Family Support and Responsibilities

Family support was important, and students also conveyed that they had to meet family responsibilities. When asked how supportive their families were about their educational pursuits in engineering, 12 of the students stated that their families were supportive of their educational aspirations. These responses were collapsed from the survey responses that ranged from "supportive" to "very supportive" on the survey question Likert scale (see Appendix B). Family responsibilities for Latina/o respondents included part-time work and taking care of younger family members. Of the sample, four students currently held part-time jobs away from the university, and two women respondents indicated that they were required to care for younger family members. The data suggested that family responsibilities and work required Latina/o students to balance and manipulate their schedules in order to accommodate their work and academic demands. However, of the students with responsibilities in the family, all were Latinas. This may possibly mean that these Latinas have more risk to finishing an engineering program. This is because often times Latinas have the responsibility to be keepers of the culture, where Latinas experience greater stress related to being successful in their educational aspirations than their male counterparts (Williams, Alvarez, & Andrade Hauck, 2002). According to Nora (2003), demands such as

work and family responsibilities pull Latina/os away from their educational obligations and cause stressors in their environment.

Financial Support

Financial support is fundamental to student success in engineering. Of the sample, 10 students received financial support from their families. Financial aid for Latina/o students came in the form of scholarships, student loans, and grants. Student loans were utilized, but scholarships and grants were the main source for student tuition funding which helped to pay for college and the needed resources such as technological equipment and books. In fact, 12 of the student participants stated that they received financial aid in the form of grants and scholarships. Student loans were also used to supplement the "free money," but were not utilized as much as student grants and scholarships. Specifically, student loans were used to help pay for college by five of the Latina/o student engineers.

Perceived Sense of Belonging to the ISU Community

Data on the perceived sense of belonging to the ISU community were collected in the survey instrument. When asked how well they felt they belonged to the ISU community, 12 students stated they felt like they belonged, and felt included in campus events and activities.

Table 4.1

Demographic Data

			Socio-Economic Status (SES)			
	Gender	Race/Ethnicity or National Origin	Student SES	Family SES	Father Education Level	Mother Education Level
Participant 1	F	Guatamalteca [Guatemalan]	< $40,000/year	Over $100,00/year	Doctoral Degree	Bachelor's Degree
Participant 2	M	Mexican	< $40,000/year	< $40,000/year	No High School Diploma	No High School Diploma
Participant 3	M	Mexican	< $40,000/year	< $40,000/year	No High School Diploma	No High School Diploma
Participant 4	M	Puerto Rican	< $40,000/year	< $40,000/year	High School Diploma	Bachelor's Degree
Participant 5	F	Costa Rican	< $40,000/year	$40,001-60,000/year	Bachelor's Degree	Bachelor's Degree
Participant 6	F	Mexican-American	< $40,000/year	< $40,000/year	Bachelor's Degree	High School Diploma
Participant 7	M	Mexican	Not Provided	Not Provided	Master's Degree	High School Diploma
Participant 8	F	Chicano, Mexican, Mexican-American, Salvadorian	< $40,000/year	< $40,000/year	No High School Diploma	No High School Diploma
Participant 9	F	Puerto Rican	< $40,000/year	< $40,000/year	Doctoral Degree	High School Diploma
Participant 10	M	Ecuatoriano [Ecuadorian]	< $40,000/year	$80,001-100,000/year	High School Diploma	Master's Degree
Participant 11	F	Mexican	< $40,000/year	$40,001-60,000/year	High School Diploma	Associate's Degree/Professional Certificate
Participant 12	F	Mexican-American, Spanish	< $40,000/year	$40,001-60,000/year	No High School Diploma	No High School Diploma
Participant 13	M	Puerto Rican	< $40,000/year	$80,001-100,000/year	Master's Degree	Master's Degree

Table 4.2

Participants' Educational Data

	Major	Academic Rank	Tranfered to ISU
Participant 1	Mechanical Engineering	Junior	Yes
Participant 2	Mechanical Engineering	First-year/Freshman	No
Participant 3	Chemical/Biological Engineering	Sophomore	No
Participant 4	Chemical/Biological Engineering	Senior	No
Participant 5	Computer Engineering	First-year/Freshman	No
Participant 6	Aerospace Engineering	First-year/Freshman	No
Participant 7	Mechanical Engineering	First-year/Freshman	No
Participant 8	Civil/Environmental Engineering	Senior	No
Participant 9	Civil/Environmental Engineering	Sophomore	No
Participant 10	Computer Engineering	Junior	Yes
Participant 11	Chemical/Biological Engineering	Junior	No
Participant 12	Mechanical Engineering	Senior	No
Participant 13	Aerospace Engineering	First-year/Freshman	No

Pre-college Experiences Impacting Persistence

In this section, themes that emerged from the focus group interviews are discussed. Overall, Latina/o students demonstrated resilience and promise before enrolling in the College of Engineering at ISU. Two pre-college themes emerged during the focus group data analysis: (a) family support, and (b) student commitment to university.

Family Support

A key theme was that of the students' families being supportive of educational ambitions. Student respondents spoke of their family support while they were preparing to transition into an engineering program at ISU in the following two ways: (a) providing assistance (i.e., help with financial planning for college, accompanying student on campus visits, and providing moral support) with the college transition, and (b) encouraging students to succeed.

Providing Assistance with the College Transition

Families who were supportive assisted with the transition to college. This was demonstrated by family members who assisted with admission application materials, ISU campus visits, new student orientation, and financial aid. One student spoke of his father as encouraging him to fill out financial aid applications in order to not have financial concerns when choosing a college:

> My dad really wanted me to go to a good college. He knew that he would not have the money to send me to an expensive school, so he went with me to my high school guidance counselor's office and helped me fill out a financial aid packet. This way, he said, I would not have to worry about cost when choosing a school to attend. He really showed me that he supported me and wanted me to be an educated man. (Participant 2)

Another student shared that her mother and father made sure to take time off from work in order to visit the ISU campus with her while still in high school:

> My mom and dad always made me feel special when it came to college stuff. I remember them both taking time off of work in order to bring me to ISU for a campus visit. Both my mom and dad have really stressful jobs, so for them to take time off in order to come to ISU with me meant a lot. As I get older, I realize that doing things like taking off work tell me that my mom and dad really care about my education and want to see me go to college and study engineering because I have always been the science type. (Participant 12)

For Latina/o students, older and more experienced siblings can be supportive agents while going through the college transition. This student spoke of her sister and the expertise she lent to the student's college transition:

> My parents and my sister really supported my adventure to college. That [College Bound counseling] is actually what my sister does now. She is a counselor for College Bound students. She counsels them when they have issues, and because of her work she knew how to help me get into college. Without my sister and her understanding of what I needed to do in order to get accepted to ISU made my job a lot easier while applying to ISU. If my sister would not have helped me I would have messed up so much paperwork. My sister also came to new student orientation with me, and she really helped me get all my classes and financial aid in order before I was on my own here. (Participant 5)

Encouragement to Succeed

One way families were supportive was by giving students encouragement to succeed in their college engineering program. Encouraging success meant that family members helped to instill the value of higher education and affirm the students' abilities that would allow them to be successful in college. Encouraging Latina/o students to succeed proved to be an empowering validating gesture. The encouragement from family allowed students to set high goals and feel like they were worthy of going to college. One student referred to his family's support in the following way:

> My dad is very supportive of my college aspirations to eventually become an engineer. When I was in high school, he told me that I had to either work with him at his job, which is very labor intensive, or go to college. He told me that I was better than just working at his job and that I needed to go to school. He is behind me all the way. (Participant 2)

One woman student spoke of her annoyance with and eventual appreciation for her mother's encouraging her to pursue a higher education:

> My mom really bugged me during the college admission process. She really got on my case about it and it was totally annoying. However, if she did not push me I would not be here today. So my mom really helped me out and I have so much more appreciation for her than I did before I came to study engineering here at ISU. My dad also helped me too. He came with me on all my campus visits and helped me learn to ask the right questions. (Participant 11)

Family support influenced the respondents to pursue higher education in order to improve their quality of life. Without the support of family during the transition to college, students may have had more hurdles to jump through and would have spent more time navigating the college admissions process alone. Family support was a factor which helped to thrust students into college.

Institutional Commitment

Institutional commitment is fostered when students develop a sense of commitment to attending a specific institution because of the various institutional characteristics (i.e., availability of financial aid, academic program reputation, faculty reputation, etc.) that allow a student to feel welcomed and proud to be part of the institution's community. In this study, Latina/os' commitment to ISU engineering stemmed from three main factors: (a) the ISU College of Engineering's reputation, (b) positive interactions with ISU prior to enrolling, and (c) the availability of financial aid options.

ISU College of Engineering's Reputation

The reputation of the engineering college at ISU helped create a sense of commitment toward an engineering program. This sense of commitment exerted a positive influence on students' decisions to remain enrolled in engineering. One student spoke clearly of the reason he decided to become an engineering student:

> I choose ISU because I lived in Illinois where there are not well-known engineering schools. The ISU engineering programs have a great reputation and that is why I came here. It was a good option for me. (Participant 7)

Another male student spoke of his perceptions of mainland American engineering colleges being excellent and well established:

> I am from Puerto Rico, and they have engineering programs. However, they do not have aerospace engineering. So I investigated U.S. aerospace programs and realized that ISU has one of the best programs in the nation. They made me realize that aerospace engineering is a very selective discipline, and that the students have to work very hard and understand a lot of information in order to be an aerospace engineer. It seems really exclusive in the USA, and they do not admit people at ISU unless they are worthy of being in engineering. The reputation of excellence at ISU also makes my mom and dad feel better about me leaving Puerto Rico for college. (Participant 13)

Another student shared her impressions of why ISU was a good choice for students who wished to study engineering:

> I came to ISU because of the reputation the College of Engineering has in the agricultural sector. One of my friends has a job with a major tractor manufacturer in Illinois and he said that mid-west companies like to hire people from ISU. I also looked online and ISU is ranked highly for engineering. The good reputation was why I applied. Once I got in and received scholarships then I knew I was going to go to ISU. I also have confidence that when I leave ISU people will know that I came from a good school. (Participant 9)

Positive Interactions with ISU Prior to Enrollment

Latina/os who had positive interactions with ISU personnel while visiting the campus set ISU apart from other institutions when considering which institution to attend. These

interactions made students feel welcome and worthy of being at ISU. One female transfer student recalled a visit to ISU that left a great impression on her and her family:

> I came to Preview Day at ISU. Preview Day is when all students who received scholarships in engineering upon admission to ISU come for a mini-orientation to the engineering college before deciding to attend ISU. So my dad and I came up to Iowa. My dad and I were there when the vice president came in and spoke with the group of minority students. He said that he loved looking at all the diverse students wanting to come to ISU and that he saw potential in us as individuals and as a group. This made me feel special and he motivated me and made me feel welcome at ISU. Also people here are nice and they really corresponded [communicated] well with me. Other schools were so rude to me, and so ISU was an easy choice for me. (Participant 11)

Communicating with students outside of ISU made this student feel like people at ISU actually cared for him, and wanted his transition to ISU to be as smooth as possible:

> I received a lot of mail and email from ISU while I was applying. I even received a letter from the Dean and a professor in engineering. It just made me feel like people at ISU were nicer and more supportive than other schools I was considering. I just thought that if I went to ISU, then people would be around to help me when I got hung up on something. I was not even a student yet and the dean was sending me letters. How cool was that? (Participant 4)

Availability of Financial Aid

Availability of financial aid was a key reason Latina/os expressed a commitment to attending ISU. Scholarships were mentioned as a deciding factor for choosing ISU. Students felt that their scholarship offers helped them decide to attend ISU and study engineering, as well as stay motivated to complete their engineering degree. Furthermore, student participants spoke of specific scholarship programs such as the George Washington Carver scholarship program (which serves the needs of students of color) and the Science Bound scholarship (a pre-college program which offers scholarships to students of color interested in studying science and engineering at ISU) as major factors in their decision to attend ISU and major in engineering. Additionally, one student received a national merit based

scholarship from NASA, while another student received a Bill Gates Millennium Scholarship to pursue studies in science and technology. This funding provided the needed access to higher education for Latina/o students and the financial support needed to progress through the College of Engineering. The following student provided a glimpse into the role the Science Bound scholarship played while choosing a college to attend:

> I am a part of Science Bound, which is a main reason I decided to come to ISU. All I had to do was attend science and technology sessions at ISU on Saturdays four times a year all through high school and if I completed the program I was given a four-year scholarship to attend ISU and study science or engineering. With my Science Bound scholarship and my other merit based scholarships I have been allowed to consider ISU a realistic place for me to go to college. (Participant 12)

Another student spoke of her receipt of a Carver Scholarship and the role it played in her decision to study at ISU:

> I came here because I received a Carver Scholarship, and it is a very good recognition at ISU. I also got into a school in New York, but I visited here at ISU and I liked it a lot better because of the nice people and the scholarship opportunities. (Participant 9)

The following student response demonstrated that national scholarship programs not affiliated with ISU can help determine a decision to attend ISU and major in engineering:

> I came here because of financial reasons. I received a Millennium scholarship (Bill Gates Millennium Scholarship) and this funding allowed me to study engineering while still being close to home. (Participant 4)

Scholarship programs provided tuition dollars to the Latina/o student engineers and held them academically accountable to the respective scholarship program. In essence, this meant that if the students did not maintain a certain level of academic standards determined by the scholarship programs then they were at risk of losing their tuition money. Without the presence of financial aid options, some Latina/o student may have not developed a commitment to study at ISU.

In summary, students chose to select engineering as a field of study because of the ISU Engineering College reputation, positive interactions at ISU prior to enrolling, and availability of financial aid options. These interactions with the university contributed to the development of institutional commitment among Latina/o students.

Academic Experiences in Engineering

Academic experiences were a factor when determining Latina/o student success in engineering. Academic interactions and experiences are at the core of the Model of Student Engagement (Nora, 2003). Two academic experiences encountered in the College of Engineering were cited as having an influence on student success. The first experience related to experiencing pedagogical problems (i.e., privileging traditional pedagogy, experiencing problems with the professor's teaching style, and experiencing invalidation) which were not necessarily compatible to the ways Latina/os wanted to experience teaching and learning. The second related to experiencing academic and interpersonal validation.

Experiencing Pedagogical Problems

Students spoke about experiencing pedagogical problems in engineering classrooms. They indicated that most of their professors employed a traditional pedagogy which was not compatible with their learning styles and classroom expectations. Also, some students experienced feelings of discrimination in their classroom. These experiences frustrated student respondents and likely lowered their expectations for their classroom environment.

Privileging a Traditional Pedagogy

As mentioned in the literature review, engineering courses faculty tend to employ a predominantly traditional pedagogy, which can hinder the success of students who may not respond well to this particular teaching method. Traditional pedagogy in engineering

disciplines means utilizing teaching methods that focus on competitive academic activity with little dialogue and interaction with the curriculum (Tsang, 2000). Latina/os in engineering appeared to be at serious risk of disengaging from their academic learning when exposed to this traditional pedagogical approach. According to student respondents, many of their engineering classes were taught to students using large lecture style classes coupled with examinations and little to no discussion. The institution's curriculum also limited the access of Latina/o students to hands-on learning until the end of their college career when they might be asked to complete one senior project. These pedagogical problems affected students negatively by leaving them with a sense of disappointment toward their classes as well as leaving them to view class time as rigid and unresponsive to their learning style needs. A student shared her experience inside the classroom where students did not engage in class and instead sat silent as the professor spoke at them:

> My very first semester here was really awful as far as my classes went. I was really surprised to go to class and only take notes and examinations. I thought for sure we would be working with machines, and science more. Instead it was just me and the students listening and taking notes. I know nobody cared about the class because everyone was either online with their laptops or texting messages on their cell phone. (Participant 1)

Another student spoke about her professor and how he would raise his voice when students would ask questions:

> I get a little nervous when it comes to going to class. In one of my engineering classes, my professor would always get frustrated when we would ask questions about topics we did not understand. It really made me feel like I wanted to change class sections. People still speak badly about that professor, and it is a class I didn't really learn a lot from. That class was like what you see in a movie because it had a grumpy professor and students who take notes and listen. (Participant 11)

The following two perspectives shed light on the lack of engagement in engineering classes. Latina/os who were exposed to these classroom settings were discouraged and bored during their learning:

> The standard seems to be lecture format and tests. There is not a lot of hands-on stuff either. It's just reading. I wish we had more opportunity to be in a lab. It makes me feel like so many people always say, sometimes things are not always the way I expected them to be. (Participant 10)

> It seems the professors do not always teach us in engineering. They just tell us to read and take a test, but I think everyone learns by doing things differently. I always have to remember that if I do not accept the way the classes are then I will fail. (Participant 7)

Experiencing Problems with the Professor's Teaching Style and Competence

A professor's knowledge and expertise did not always translate into teaching. Students held great respect for their professors but realized that some members of the faculty were not the best teachers. One student spoke about his respect for his professors as experts, but that they did not know how to convey their knowledge:

> A lot of the professors are great and have strong backgrounds. The only problem I find is that they are not very good teachers. They seem to not be good at teaching other students what they know. This is a big disadvantage for a student because it discourages us from learning the material with a greater understanding. We seem to just do the minimum and memorize a lot. There is not a lot of interaction in class. (Participant 13)

There appeared to be a "weeding out" of weaker students from rigorous class learning. One woman student spoke of her environment as being extremely rigorous in order to force weaker students out of engineering:

> If you ask me, the teachers here do not allow students to be creative. We are allowed to when we are seniors but as younger students it seems like the professors just want it to be one way and really hard. I always wonder if it is because they just want to get rid of people who are not serious about being here. (Participant 12)

Another student shared his experience in the classroom as intimidating and unfriendly. He too was left with the feeling that the professors were trying to get rid of the less serious students in the class:

> I was so confused when I had a class where a professor spoke about how the class was meant to show students that engineering is not easy, but hard and only the strong students can finish. I was confused because ISU always says how the professors care about students, but really they do not want to deal with people like me who are weaker in certain subjects, and may struggle in certain classes. It does not mean that I do not want to be in engineering. (Participant 3)

Another woman asserted her belief that students are not all the same and that faculty members may not recognize this diversity of learning abilities in their classrooms:

> It seems like the teachers only teach one way, and you must learn that way or else it is a problem. Students are ready to learn different things and different ways. Whether it is math or engineering it seems like they teach it only one way. (Participant 1)

Experiencing Invalidation

Students were asked to speak about the negative aspects of their engineering program. Responses were primarily invalidating for students both in-class and out-of–class. Research participants expressed their experience with invalidating interactions they encountered during their engineering experience. Invalidation can involve refusing to respond to student requests and questions, singling out a student in front of their peers, not responding to student emails or phone calls, and embarrassing students. Overall, students entered their engineering programs adequately prepared and fairly confident with their ability to be successful in engineering. However, when they sought out to engage further in their learning with certain faculty members they were made to feel incompetent and unsure of their abilities. Specifically, invalidating experiences in this study occurred in an academic setting among students and professors. Students who were interested in gaining more in-depth information

about their academics were thwarted away by negative interactions with certain professors. Invalidating interactions with professors made them doubt their ability to be successful in engineering. Whether invalidation was discriminatory or embarrassing in nature, it still had the potential to disrupt a student's educational journey. One student experienced an out-of-class invalidating experience with her professor that was both interpersonally and academically invalidating:

> I have had a professor who was negative. He was a visiting professor with language barriers. Every time I would go and ask for help he would tell me that he would not give me the answers to class assignments. I told him I did not want the answers and that I wanted understand the process of how to get the answers. We even raised our voices at one another because I would get frustrated with him. Then he helped me because I stuck up for myself. I even notice that when men come and ask questions he would be very helpful to them. I guess he favored men over women. I just always felt he looked down to me, and eventually got fed up with it. I am so much more confident now after interacting with my stubborn professor. It was scary at the time but I am glad I did not give up. He still made me feel insecure though. (Participant 11)

Embarrassing experiences in classes between student and professor also disrupted the confidence of students. One student shared a significant example of how his calculus instructor invalidated him in the class by yelling at students:

> I do not know if it is a negative, but I have a professor in calculus and he is pretty hard and yells at the students. He would make students and I feel embarrassed. He would get mad when we would give him the wrong answer. Like if the students don't know how to do calculus then it makes him look bad. I remember feeling embarrassed a lot when I was wrong. He was a graduate student by the way in the math department. I learned more about myself than anything else and how I will face people like him in college. (Participant 3)

Further, women face a chilly climate in engineering which can be invalidating. Because engineering is dominated by a white male culture, women often times find themselves having to endure discrimination and uncomfortable learning environments. These intimidating learning environments have the potential to seriously invalidate a student academically:

> In one class there were only three women and the professor put the three women together in a group. Then the rest of the 30 or so men in the class were put into their own groups as well. And the professor even said out loud "I want to see how this works out…the women versus the men just to see what happens." It felt like he was being experimental and unfair since there was only three women in a class of about 35. I don't really know what to say about it but it was awkward and made me feel like we were different than the guys. I did not like it so much and it made me feel like he was experimenting with us just because we were women. (Participant 1)

> One class I was the only girl in the class. If I had a question the professor would help me and assist me. But when I said something wrong it was like he and the other students doubted me and questioned my ability. It's like if I did not get questions right then I should not be in engineering. (Participant 9)

Classrooms like those described here, embodied a traditional and limiting pedagogy. Traditional pedagogy in engineering was described by Latina/os as employing primarily a lecture format, having invalidating elements, lacking hands-on learning, limiting the discussion, positioning the faculty as an expert, and employing assessment in the form of quizzes and tests. A lack of excitement about classroom experiences was clearly evident. Nonetheless, in the next section validating interactions with faculty showed that excitement for learning was possible.

Experiencing Academic and Interpersonal Validation

One important type of experience expressed that was positive in nature was validation. Validation occurs when institutional agents such as faculty, support staff, etc., take action to empower and encourage students (Rendón, 1994). In this study, both academic and interpersonal validation occurred between faculty and students. Such interactions with faculty appeared to foster empowering academic experiences.

Interestingly, while certain professors were perceived as not teaching well, some professors played a fundamental role in helping Latina/o students believe they could achieve their academic aspirations. These professors engaged students in the class material, affirmed

students' abilities, and offered assistance and guidance outside of the classroom. Validating educators reached out to students and created a safe and fun learning environment. High expectations coupled with validation created confidence in the students and allowed them to move toward academic success. When asked whether Latina/os have positive and encouraging interactions with faculty members who kept them motivated to stay in engineering, student responses were highly positive. Academic opportunities and collaboration between students and faculty helped give students the confidence of knowing that they were capable members of the academic environment and that they were accepted by their community in engineering. One male student shed light on the positive interactions Latina/o students had with professors who offered validation and encouragement to succeed. He shared how one particular professor validated him:

> I have one fresh memory. I went to talk with my professor in my engineering class and I went to him in search of work opportunity. First, it is important to know that engineers must have experience. I went to him and said that I need to have experience in working with engineering. I asked what I could do in order to work or make connections in the engineering field. He referred me to another engineering professor who ended up showing me opportunities to learn about working. He actually helped me out with giving me some options for people like me who are not experienced. He showed me a lot of senior design projects that were incomplete and he told me that I could pick any of the incomplete projects and he would work with me on finishing it and learning about it. He said that I should finish the project with him and get independent study credits during the summer so that we could show the complete project to the new students in the fall. He even said that I could come into the labs whenever I wanted and mess around with the equipment and stuff like that. It really showed me that asking for opportunities helps a lot. I feel so honored to have worked with a professor all by myself. (Participant 10)

A female student experienced academic and interpersonal validation inside the classroom with teaching assistants and faculty members. She spoke of how her professor inspired her, set high expectations, and cared for students:

> The thing that I like about my major is the science involved in the classes and some helpful instructors. Many of my professors are so boring, but one time I had this woman professor who showed us that our major can be fun. She really inspired me to become passionate about my major. She was also very nice to all the students in the class and expected a lot from us which made class kind of hard. However, her demands made me like her more because I felt like she actually cared about my class time. (Participant 11)

Similarly, another woman spoke about her teaching assistant as being welcoming and able to create a fun learning environment for a dull subject:

> I really enjoy my classes. I am in a learning community which is for women engineers. Because of that we have classes that have recitation sections for women and are taught by a woman. This class was engineering dynamics and statics [engineering mechanics] class and the teaching assistant was awesome. She was so nice to me and the other ladies in class and turned a totally boring and dry subject into something fun and engaging for us. It left me with a good feeling seeing another woman who is not white and is teaching in a university. (Participant 5)

Validating actions that made students realize they were capable students were also experienced. Some students spoke of their engineering 101 classes as being boring but also very affirming. One student shared his experience in the introduction engineering class:

> In our engineering 101 class, which is taught by our advisers, we learn all about the engineering college and the ISU resources. This class was so boring and dull sometimes, but what I took out of it is that I am supposed to be here [ISU]. There is so much work in the field of engineering to be done, and I can contribute. My engineering 101 class allowed me to think about the ways I can change engineering. It really inspired me to become an engineer, even though the class was really boring sometimes. (Participant 3)

Social Experiences in Engineering

Two distinct social themes emerged. These two specific social themes were: (a) peer support, and (b) resourceful mentors and role models.

Peer Support

Students relied significantly on fellow students (Latina/o and non-Latina/o) who were older and more experienced in engineering. Student-on-student counseling and advising was

the fastest and most relied upon source of academic advice and information for Latina/os. Students relied on each other because of the 24-hour access students had with one another through technology such as cell phones and instant messaging computer features. Nevertheless, some of this student-on-student counseling proved to be troublesome for some students because of the misinformation or lack of knowledge spread when one student counseled another on topics such as academic curriculum and university bureaucracy. While it was nice to have more experienced students as a resource, they did not always possess the needed and correct information. One male student spoke of his reliance on fellow fraternity brothers:

> When I have questions I just ask my fraternity brother. They are more experienced than I am and are able to give me information I could not get anywhere else. I still go to my advisor sometimes too. One time my fraternity brothers were wrong about classes I should take and the adviser had to help me because the fraternity guys gave me the wrong information. I would have wasted a whole semester if my adviser had not caught the wrong information I received. (Participant 3)

One male student spoke of the positive benefits of seeking advice from other students and how faculty were not always available like students. Access to faculty was a barrier for this student when seeking help from university personnel:

> Well, a good thing is that if you need help you can ask other students. It seems like the students help one another because we are able to get fast answers from our peers instead of waiting a week to meet with professors. So current students and graduate students are always around and have the ability to help me and other students. (Participant 2)

A woman shared her reliance on the ISU chapter of the Society for Hispanic Professional Engineering (SHPE). She relied on this organization for professional advice because she related more to the people who represent SHPE:

> I participate in SHPE which focuses on people who are not represented in engineering. I would join the civil engineering group but it's so big that nobody even

> notices you there. It is not welcoming. So I joined SHPE which is way more accepting of me and my goals. They also represent my people and I can be around people who are like me. (Participant 5)

Specific experiences among students were varied. However, there appeared to be more risk than benefit when Latina/os relied on one another for university information. Students were genuinely motivated to help one another. However, they were not properly informed to advise and counsel one another when it came to college and professional preparation.

Mentoring

Student respondents spoke of their mentors and role models in their engineering program. These mentors included professors, student affairs professionals, and advisers. Specifically, professors allowed for relationships with students wishing to gain professional competence, while student affairs professionals connected students with resources and support. Professors were some of the most powerful mentoring agents available to students. Professors provided students with exciting opportunities to work on team projects like a solar car building team and computer programming experiments. One man spoke highly of his professor and the chances he gave him as a young scholar:

> I trust the professors that I have classes with because they know my name and know what's going on in my life. They have a certain care for me when I get to know them better. My faculty advisor has been a wonderful mentor of mine. He is super supportive and excellent with everything he does. He is as good of a teacher as he is an advisor. The way he interacts with the students around me is great. It seems like all professors just call students by their id number or some nick name they make up for a student but not my faculty adviser. He knows students names and takes interest in their life and their potential. He looks at each student differently. (Participant 13)

Student affairs professionals were also important resources for students. Take for example the Multicultural Liaison Officer (MLO) in the College of Engineering. An MLO is a student affairs professional embedded within the engineering college. This person is responsible for

ensuring that resources needed for students of color studying in engineering are provided. The role is as advocate and adviser to students. During focus group interviews, students spoke of their interactions with the MLO in engineering:

> The MLO (Multicultural Liaison Officer) is awesome. She is very helpful. She always is offering assistance or telling us to come to her if we need help. I have gone to her for a lot of stuff in my life. I just like that the office she has for us is always open and she allows us to be in there or use it as a meeting place. It is like a little corner of the university is left just for me and a fairy god mother, my MLO, comes along with the office. (Participant 9)

Latina/o students also spoke about their relationships with their advisers at the university. The following students represent the encouragement and support which came from the academic adviser:

> The first place would be my adviser in Multicultural Student Affairs (MSA) at ISU. She has been here since I started school at ISU. They have been there for my journey supporting me and my goals while I am here at ISU. (Participant 13)

> My advisor helped me after a tough semester this past year. I am on my fourth year and he advises a lot of students and he told me that he knows I am capable of being in my program and telling me that he believed in me while I was getting frustrated during a rough spot in my life. (Participant 5)

The presence of positive mentors and role models during the educational journey provided needed support and confidence, giving the students the sense that they were cared for and valued in the university.

Summary of Findings

The majority of participants in this study came from supportive middle-class families and had adequate high school preparation for engineering in college. The profile of primarily middle-class Latino families in this study suggested that class is a factor when determining college success. The results of this study showed that Latina/os can be well prepared for engineering and have the needed support to succeed in a major where only a few Latina/os

graduate. Specifically, it is possible that these students represented the very small number of Latina/os who successfully passed through the engineering college. As noted in chapter 1, of the nearly 900 engineering degrees awarded in 2006, only 11 were awarded to Latina/os.

Three themes emerged from this study. First, pre-college experiences appeared to have a great impact on college success. Latina/o respondents in this study had supportive families and a commitment to attending ISU. Family support placed high value on higher education and allowed students to choose a college that was most conducive to their needs and goals. Commitment to ISU stemmed from the reputation of the ISU engineering programs and the positive interactions Latina/o student experienced while visiting campus before they decided to enroll.

Second, academic experiences of Latina/os in engineering were major factors which affected students' excitement about learning in engineering. Validating interpersonal academic interactions with some professors helped students engage in their learning which created a sense of worth among the students. On the other hand, some students expressed frustration and disappointment with their classroom learning. These frustrating experiences related to pedagogical problems such as privileging a traditional pedagogy and students perceiving their professors as poor teachers. Students wished for more dialogue during class and more hands-on experience in the labs, especially during the first two years as an engineering student when they were more impressionable.

The third theme related to social experiences. Students depended on one another for advice and support with academics and professional preparation. However, this proved to be troublesome for Latina/os whenever they were misinformed and inadequately advised on important issues related to their success. Nonetheless, this supportive relationship among

Latina/o students showed that Latina/os do seek advice from people who can empathize with them. Additionally, the presence of role models and mentors proved to be helpful and valuable. Positive interactions with mentors and role models on campus allowed students to seek out new opportunities and set high expectations for their learning.

These results demonstrated that Latina/o students can be successful in engineering disciplines. While Latina/os remain underrepresented in science and technology industries, findings showed that with the appropriate institutional support and reform of classroom practices, Latina/os can thrive in a field even when they exist in small numbers. Institutions need to create the necessary conditions for success of Latina/os in engineering. Success of Latina/os not only depends on the individual, but on the institution whose responsibility it is to create safe and nourishing learning environments for all students. In the next chapter the findings and conclusions will be discussed, and a conceptual model for student success in engineering will be introduced. Recommendations on how to facilitate Latina/o student success in engineering fields of study will also be presented.

CHAPTER 5. DISCUSSION, RECOMMENDATIONS, AND CONCLUSIONS

Introduction

The results presented in the previous chapter shed light on the experiences which emerged as significantly affecting the persistence of Latina/o students in engineering fields of study at ISU, a predominantly white institution. This chapter will discuss the findings gained from the study, make recommendations for higher education professionals, and suggest future research for the academic community.

Model of Latina/o Student Success in Engineering

To guide the discussion of findings, a Model of Latina/o Student Success in Engineering (Figure 5.1) was developed. The model characterizes the three main determinants that facilitate student success in engineering fields of study. The three indicators of success were: (a) pre-college experiences (i.e., high school preparation, family support, campus visits, recruitment, and high school college guidance counseling), (b) academic experiences, and (c) social experiences. The model is representative of the profile of Latina/o students who participated in this study and who symbolize a predominantly middle-class group of students with adequate preparation needed to progress through the engineering program. However, some students came from families with at least one parent who did not graduate from high school. Further research would be necessary to situate a model for student success into a profile of students who may enter the institution with negative experiences that caused barriers to their college success in engineering fields of study such as inadequate high school science and mathematics preparation, lack of family support, unavailability of financial aid opportunities, and diminished institutional commitment.

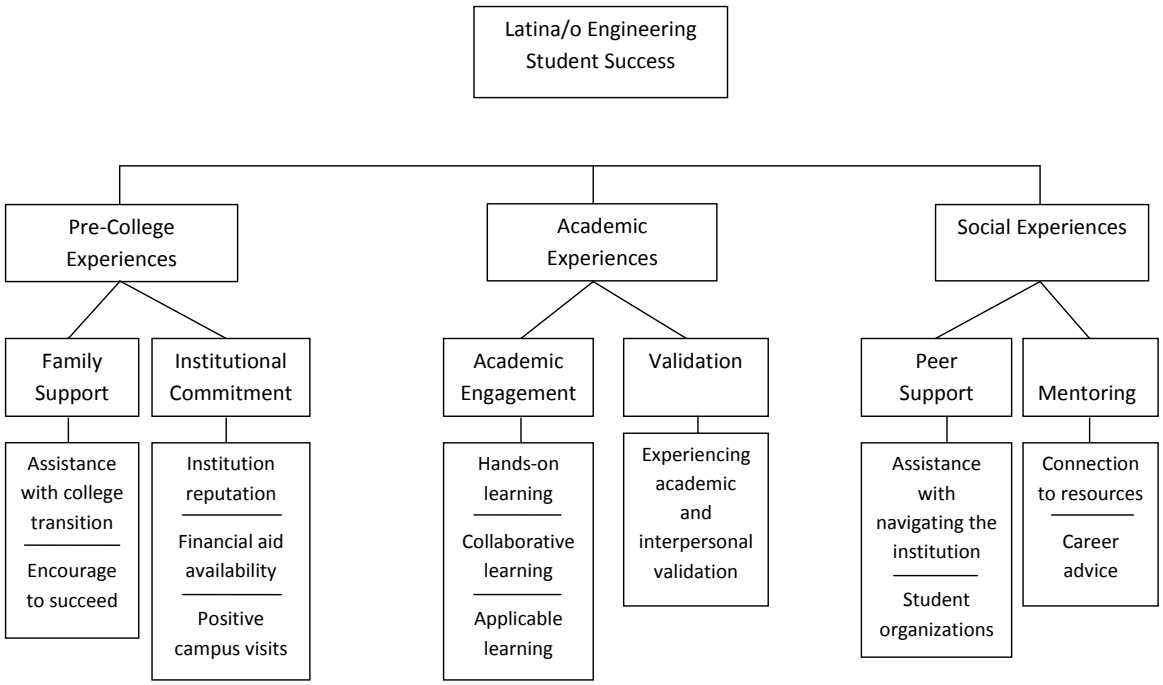

Figure 5.1. Model of Latina/o Student Success in Engineering

Pre-College Experiences of Latina/o Students

The first set of determinants of student success consists of pre-college experiences (i.e., family support and institutional commitment). The model supports several of the factors related to Latina/o success as presented in Nora's (2003) framework. The findings also confirmed Rendón's (1994) validation model.

Family Support

Similar to Nora (2003), Rendón (1994), and Nora and Cabrera (1996), the present study found that family support exerted a positive influence on the students' ability to transition into and adjust to the new college environment. Studies show that when students can transition successfully they are likely to succeed academically and remain enrolled in

college (Garrod, Kilkenny, & Gómez, 2007; Nora & Cabrera, 1996; Zalaquett, 2006). The results of this study on Latina/o engineering students confirmed previous research which indicated that students who have support during the college transition are more likely to succeed and persist to graduation. Without such support Latina/o students are left to fend for themselves and possibly view the college process as too complicated to navigate. In Nora's (2003) Model of Student Engagement, family support is fundamental to creating a solid foundation for student success prior to enrolling in the institution.

Institutional Commitment

According to Nora's (2003) model, institutional commitment is an important component of student success and is determined by the level of commitment a student possesses for attending a specific institution. The students in this study were highly committed to attending ISU and were influenced by the college's reputation, positive experiences at ISU prior to enrolling, and ISU's ability to offer enough financial support to students who wished to study engineering. From these findings it can be inferred that institutional commitment is unquestionably a pre-college factor that influences a student to attend an institution and enroll in an engineering field of study. Positive and empowering experiences with ISU prior to enrolling gave way to an increased sense of commitment. These positive experiences and interactions with the ISU community appeared to create excitement and willingness to be part of the college community at ISU. Furthermore, excitement about being a student at ISU—coupled with adequate financial aid and a student's perception of the university as being a celebrated institution—likely allowed students to focus on academics and not on concerns such as costs associated with being enrolled at ISU. This leads one to conclude that institutional commitment can be fostered by creating

recruiting strategies such as ISU pre-college programs, workshops, and orientations. The absence of such experiences during the pre-college process may not foster as much institutional commitment, which in turn may create barriers to a student's persistence in engineering fields of study.

Academic Experiences

Academic experiences of Latina/o students in engineering were perhaps the most highly influential of all experiences that affected the success of Latina/o students. Nora (2003) demonstrated that academic experiences, including involvement in class activities, receiving encouragement from faculty members, and participating in collaborative learning, are important factors in determining student success. Positive academic experiences are significant factors that influence student's persistence in Nora's (2003) Model of Student Engagement. In the present study, academic experiences related to pedagogical problems and validating academic interactions were of particular importance. Interestingly, academic experiences were both negative and positive. The problematic experiences identified by research respondents were centered on the lack of engagement in their classes. Conversely, positive experiences indicated that students felt validated by their professors.

Countering Pedagogical Problems with Academic Engagement

A lack of diverse and engaging teaching methods in engineering classes appeared to diminish interest and excitement about academic experiences. The competitive nature of classes and lack of hands-on learning, particularly in the first years of college, produced frustration for students interested in engaging in more in-depth and collaborative learning experiences with their professors, teaching assistants, and fellow students. The problematic experiences related to lack of engagement in classroom learning had the potential to

contribute to students perceiving the field of engineering as rigid and inflexible to their needs. This could lead to causing students to change their academic objective or to leave the institution altogether. A key conclusion here is that engagement becomes paramount if Latina/o students are to persist in their respective engineering program. Overall, the use of traditional pedagogy limited discussion and engagement with academic material. Lack of engagement might serve to oppress Latina/os within the engineering culture that already has been shown to marginalize women and people of color (Brown, 2002; Chang, 2002). Engineering fields of study can embrace an engaging pedagogy in engineering classrooms which can create excitement for learning and application of new knowledge. According to Kuh, Kinzie, Schuh, and Whitt (2005), who employed the National Survey of Student Engagement to summarize effective educational practice, students learn more when they are actively engaged in their learning and have opportunities to apply what they have learned in practical situations. Unfortunately, to Latina/o engineering students, this active engagement is clearly absent from their classroom experience. bell hooks (1994), in her book *Teaching to Transgress,* argued that engaged pedagogy includes focusing on the whole student. When focus is given to educate the entire student (i.e., attends to the intellectual, social, emotional, and spiritual development), more engaged learning can take place. Engaged pedagogy rejects the banking system of education (i.e., providing facts to students with little discussion and application, placing emphasis on the students' ability to recite information gained in class on command, and viewing the professor as the only expert in a classroom) currently employed in Western school systems. Holistic teaching of students attempts to attend to the mind, body, and soul of students to ensure that people are educated as humans and not as machinery in need of programming. Specifically, more dialogue in the classroom would allow for

increased engagement in class and could be more responsive to different styles of learning. While this pedagogical approach may be met with overwhelming resistance and rejection in engineering fields of study, it should still be considered in engineering classrooms in order to not only teach knowledge from books but also to impart knowledge on how to live in the world (hooks). This would prove to be a fitting approach to teaching engineering students who are now part of a global engineering community.

Engaging students in the classroom is important for student development and achievement to occur. When students are not engaged in their learning, their commitment to their education falters (Nora, 2003). This is especially harmful for Latina/o students who may view the classroom as not welcoming and unresponsive to their learning needs. As Nora suggested, lack of academic engagement is perhaps a contributor to students' lack of persistence; they may view the obstacles to their learning as too great to overcome, thus possibly resulting in their decision to drop out or change academic majors.

Academic and Interpersonal Validation

Even with less engaging classroom environments, validating interactions with some members of the faculty gave students the needed encouragement to persist. Examples of academic validation (Rendón, 1994) occurred when faculty engaged students in classroom learning, created excitement around curriculum, and encouraged collaborative and hands-on learning. Rendón asserted that academic validation is important to student success and can engage students in their learning and create an ethic of care. Validating faculty also set high expectations for their students such as requiring more frequent and demanding assignments, challenging students on course assignments, and requiring students to read heavily. These high expectations allowed students to perceive their classes as challenging and more

rigorous; at the same time these high expectations could possibly alienate students. However, upon completion of difficult classes, Latina/o students gained confidence and determination because of succeeding in challenging classroom environments. What was learned was that when demanding course work was coupled with high expectations and validation, Latina/os could view their academic experiences more positively and leave with a sense of accomplishment and fulfillment.

Validation from professors in the classroom is vital to Latina/o student success in engineering. In focus group interviews, student respondents who had positive experiences in the classroom almost always gave credit to their instructors for such experiences. Validation theory (Rendón, 1994) showed that validation has the potential to encourage and empower students to view themselves as worthy and solid contributors to their academic community. Validation can include calling students by name, helping students realize their potential, encouraging students to participate in research, and viewing students as worthy contributors to the learning environment. Such validation is important if professors are to develop the confidence and skills of Latina/o students who aspire to positions in engineering. Latina/o students spoke of specific faculty who were available for consultation about course work, internships, and future career opportunities. To some students, it took only a few irregular visits with their professors to show that quality interactions with their professor were sometimes more fruitful than interacting with an unresponsive professor in the classroom on a regular basis. Not only did supportive professors provide the needed validation for some students, they also became a trusted mentor and role model. A key conclusion is that validating interactions with the faculty members in engineering have the potential to empower students. However, invalidating experiences were also occurrences in the students'

engineering experience. These experiences were significant sources of discouragement and had an impact on students' confidence and ability to take initiative to interact with their professors.

Social Experiences

The data from this study revealed two kinds of social experiences that positively influenced students: (a) peer support, and (b) mentoring. Nora (2003) established that social experiences such as peer group interactions, involvement in student organizations, and students' perceptions of the campus climate as being a safe environment are important factors in determining student success, Positive social experiences are significant factors that influence student's persistence in Nora's Model of Student Engagement.

Peer Support

A key finding was that peer support can be both rewarding and worrisome. Student respondents may seek advice and counsel from fellow students (Latina/o and non-Latina/o) who are older and more experienced in the College of Engineering. Fellow students were identified as older, more experienced Latina/o peers and siblings, fellow fraternity and sorority associates, classmates, and engineering graduate students. Relationships with these peers can be both helpful and possibly unproductive. While it is usually expected that Latina/o students seek help from fellow students in order to develop a sense of interdependence, it should be noted that seeking such assistance can pose potentially serious derailments to a student's educational journey. Students who counsel other students without training or professional expertise in college advising may have wrong information or biased impressions of certain faculty members and curriculum. This has the potential to disrupt a

student's journey and set him/her back because of the possibility that students may be steered in the wrong direction.

At the same time, positive peer support through student organizations and clubs allowed students to become connected to university services and resources during their college journey. In fact, organizations that catered to specific populations within a specific field such as the Society of Hispanic Professional Engineers (SHPE) provided a forum that fostered peer support for Latina/o students in engineering fields of study. During such interactions with their peers, students shared professional and college experiences relevant to the student members, which also helped create a sense of community. A key conclusion is that peer support can be highly valuable if conducted with trained student leaders and peer-mentors.

Mentoring

Professors and student affairs professionals proved to be important mentors by connecting students to institutional resources and providing career advice. Without successful mentoring, students might feel that they were not part of the engineering community. A key conclusion is that it is important that experienced and capable mentors within the engineering community guide Latina/o students through their college experience. Mentors and role models can not only introduce campus resources to students, but actually help students learn to utilize resources to their benefit. Mentors and role models are vital contributors to student success in a field like engineering which advocates the value of individuals. While students in this study spoke of professional mentors and role models, fellow students could also serve as mentors and role models. Properly informed student leaders in programs like new student orientation and student organizations can empower

younger and less experienced students through discussions about internship experiences, the path to a career, and senior research projects. Unfortunately, since Latina/os are a small population in a college with thousands of students it is vital that higher education institutions provide mentoring relationship opportunities to students who decide to study in fields where they are significantly underrepresented and marginalized by an incompatible system of instruction, advising, and social engagement.

Recommendations for Student Success

Learning about the pre-college, social, and academic experiences of Latina/o students can allow higher education practitioners, administrators, and policy makers to understand how Latina/o students experience their college environment as engineering majors. Most interesting was that the findings established that the experiences of Latina/o students as they navigated the College of Engineering were mainly positive and developmental. Although every university and college is unique in its own right, it is important that they all be properly organized and prepared with broad data driven (both positivist and constructivist) decision making processes before moving forward with any strategies for student success. The following recommendations are meant to assist higher education practitioners, administrators, and policy makers in facilitating an increased likelihood of Latina/o student persistence in engineering fields of study.

Recruit a Broader Pool of Students

The students represented in this study included a small group of students who were situated for success before they even entered the university system. The survey data from this study showed that students who were primarily from middle-class families with adequate preparation for engineering and minor barriers to their success were heavily recruited by ISU.

However, a broader and more embracing recruiting system for engineering programs should pay specific attention to high-potential students who want to study engineering but may come from low-income families, lack adequate high school math and science preparation, and have barriers to their educational aspirations. These students may not understand the world of higher education and may have attended resource-poor schools. It is possible then for these students to fall through the cracks during the college admission process and miss opportunities to attend college. The university should be responsible for providing financial and human resources in order to facilitate a recruiting process that aims to recruit students from a broad range of backgrounds. This is especially important for the students who may be ready for success but lack the necessary pre-college experiences, thus hindering their access to higher education. A commitment to broad student recruitment can help increase access for all students and especially the Latina/o students who want to go to college but may not see it as a practical option for them or their family.

High schools must also take responsibility in recruiting potential student engineers to college. The knowledge that a high school teacher or guidance counselor has about a student's ability and aspirations has the potential to steer that student toward a path of success. Often times language barriers exist for family members with students who want to go to college. This can significantly limit the participation of family members in the college admissions process. High schools can bring recruitment programs into their schools through hosting college information programming during the day and evening hours for families who wish to learn more about what it takes to go to college. Offering information (in English, Spanish, and other relevant languages) to families about financial aid options for college will hopefully help them support college as a possibility for their children since financial anxiety

is a real barrier to higher education. Additionally, addressing the language barrier that plagues many Latina/o families can also help broaden the pool of Latina/o engineering students. It has become increasingly important for college informational programming to be offered in Spanish (the dominant language spoken by Latina/o families) for family members. This is important because language barriers have the potential to leave interested family members in the dark when it comes to college outreach programming. If higher education institutions expect to engage a broader group of Latina/o students in engineering then active recruitment involving both students and families is important.

Expand Outreach to Latino Families

Higher education practitioners, administrators, and policy makers who seek to advance understanding of Latina/o students must be aware of the critical role a Latina/o's family plays throughout the college journey. Family support is a critical resource when deciding to attend college and even more important when deciding to study engineering. Active outreach to families in Latina/o communities in the form of financial aid workshops, admissions workshops, and science and mathematics programming will allow for a student and his/her family to become comfortable with the idea of attending college, thus increasing the family support a student has to attend college. Instead of offering programming to students primarily at the ISU campus (which is the primary setting for outreach activities), more activity needs to be executed at the local level for high school students who aspire to go to college. Offering programs at ISU is helpful because broader outreach and recruitment can help develop institutional commitment, but many students may not have access to the means that are required for such participation. Therefore, active outreach which speaks to Latina/o families and their concerns is a vital component of engineering programs.

ISU personnel should be mindful of the Latina/o family dimension and include family members in recruitment, orientation, and outreach programming. Including family members in workshops about financial aid, having bilingual student employees in campus offices, making campus resource materials available in other languages, and embracing an overall inclusive planning process can greatly improve the chances that a student will gain family support for attending college and become more likely to persist to degree completion (Arellano & Padilla, 1996; Castellanos & Jones, 2003). Recruitment is also a significant opportunity to engage a young Latina/o student's family in the college process. Recruiting the family members to support a particular student's dream of attending college is just as important as recruiting the student. If family members are more invested in their student's experience, the chances of a family being supportive are more likely. Therefore, including family members in recruitment and all other relevant college programming answers questions for families and makes the college journey appear to be less unknown, overwhelming, and frightening.

Foster Institutional Commitment

How can ISU foster a student's institutional commitment? The reputation and awareness of ISU's engineering college was a major source of institutional commitment for many students in this study. It is important that marketing of engineering programs continue and that the reputation of ISU as a major engineering university continue to spread throughout the state and nation, especially in high schools. Moreover, marketing strategies created specifically for Latina/o youth would improve excitement for possibly being a student at ISU. It is validating for Latina/o students to attend such a well-known engineering program like that of ISU. It is important to communicate to young people that they are

worthy and capable of being successful student engineers at ISU. When students have a sense that they belong in a certain place of study, they will likely develop significant institutional commitment.

Besides marketing the solid reputation of the engineering program at ISU, the university can enhance a student's institutional commitment prior to his/her enrollment by sending engaging messages of support and salutation. Letters of welcome from a dean or recognizable administrator (perhaps a Latina/o professor, which students in this study identified as not existing in the College of Engineering at ISU) would be a helpful way to greet a student during the admission process. This has significant value because it tells students that they are viewed as members of a community and are worthy and valued contributors. However, letters cannot create institutional commitment alone. Welcoming messages must be followed up by assistance with transition programs and resources if needed. This is to ensure that after sending highly positive welcoming salutations, students feel supported and connected to the college.

Employ Engaging Pedagogy

It should go without saying that the classroom is a critical part of the college experience. Therefore, an examination of classroom experiences is essential to any study on student persistence. Latina/o students were positively and negatively influenced by both engaging and non-engaging classroom environments. The engineering classrooms can be engines which allow students to thrive, or they can be places where students feel oppressed and invalidated. To combat this oppression, administrators and professors can consider integrating active learning into their classroom in order to create active and engaging opportunities for growth and learning. Active learning may include:

1. Having students make classroom presentations
2. Requiring that students engage in class material in collaboration with other students outside of class time. This can include having students prepare class assignments together, conduct experiments in teams, as well as offering independent study for undergraduates
3. Tutoring or teaching other students
4. Holding discussion groups about readings during class time in small and large groups

These active strategies represent only a few. Professors and teaching assistants who teach engineering courses to undergraduates can creatively generate ways of teaching their subject matter in a manner which yields more student engagement and excitement. These opportunities are methods for faculty members in engineering to validate students and their abilities.

Working collaboratively was a major experience which advanced the student development of participants in this study and engaged them in their classroom environment. Student respondents spoke of engineering as a global industry. These students recognized the importance of working with others and learning from their fellow students. Collaborative work aided in fostering student interdependence. Higher education personnel should note that collaboration can be a powerful learning experience that can prepare students for a more collaborative and global engineering industry. Professors, especially in engineering, can increase opportunities for students to collaborate. Student who collaborated with others gained insight into how people have many different working styles and come from different

cultural perspectives. Therefore, professors can increase a student's interdependence and cultural awareness through collaborative work.

Faculty members can reject the traditional methods of teaching which prize only competition, position the faculty member as sole expert, value only positivism, and lack discussion. By rejecting these narrow ways of delivering academic material to students, a more free-flowing environment full of dialogue and critical thinking can positively influence a Latina/o student to be more than an average student. It is time that professors become more creative in their delivery of material to students. It is also time for universities to reward teaching and the professors who engage their students in classroom success. Policy makers and administrators, such as deans and provosts, can help to transform classrooms in engineering colleges. These high-level leaders can affect change in the classroom by providing resources to professors and student service personnel to help them teach a diverse range of students. It is through the aforementioned offering of resources that higher education professionals can create validating and engaged academic environments for their students.

Validate Students

This study found that when validating professors were present in a classroom and encouraged engagement in the material, students were positively influenced. Students spoke of how certain professors and teaching assistants empowered and inspired them to want to learn more. This was evident in many students participating in independent study with professors and taking more initiative to master certain course material. Therefore, it is the responsibility of the professor to reach out to students and help them succeed. Some examples of ways to validate students can include:

1. Help students see that they are worthy contributors to classroom learning by asking students to share their experiential knowledge as it relates to course content
2. Use out of class meetings to help students explore career opportunities
3. Include undergraduate students in faculty research
4. Provide opportunities for students to help engage in teaching of class curriculum
5. Encourage students to participate in academic projects such as student research conferences
6. View the student as a worthy contributor to the academic environment
7. Call a student by his/her name
8. Serve as a mentor for students

Promote Mentoring Relationships

This study demonstrated that mentoring is a powerful force behind student confidence and success. Mentoring a student should be a goal of higher education professionals. Professors, administrators, student affairs professionals, graduate students, and high-level campus leaders are members of a university environment who can serve as mentors to underrepresented students. Mentoring can allow a student to feel connected and assisted during a time of self-discovery and self-growth. Without a support network such as mentors, students can feel isolated from their community and retreat from their academic aspirations. Therefore, any practical model for student success must include mentoring opportunities, both formal and informal. Mentoring relationships between students and institutional agents are powerful opportunities to discuss future career ambitions of a student and even encourage students to continue their education in graduate school.

Promote Peer Support

In addition to mentoring relationships, peer support is an important relationship to create in a higher education environment. In this study, peer support was seen as necessary and important. However, ISU must be mindful that not all peer support is helpful. In fact, in this study peer support was sometimes shown to be worrisome and risky. Fellow students of Latina/os were most likely not trained academic advisors or teachers. Therefore, students ran the risk of getting bad information from fellow students or biased information about certain professors and classes. It is important that appropriate advising be in place to ensure that all students are getting proper information that moves them forward during college, and not backwards.

ISU can set up initiatives which aim to train student peer-leaders. Peer-mentoring programs can help connect students to correct and accessible information about college from their peers. For example, at California State University Fullerton, new students are encouraged to take a university studies course that introduces students to university organizations, resources, and advising. In each of their university studies courses, trained students in their junior or senior year of college serve as peer-mentors and help to facilitate the university studies class. The role of the peer-mentor is to be available for new students who may need guidance during their college transition and to help introduce new students to student life at CSUF. These relationships help students connect to the CSUF community at the beginning of their college career and foster peer-support among the student body.

Recommendations for Future Research

This study addressed the experiences that contribute to Latina/o student persistence in engineering fields of study, but more research is needed in this area of inquiry. This section

addresses the areas which require further investigation in the study of Latina/o student persistence.

Experiences in Pre-college Programming

Many programs exist to serve as recruiting strategies for universities to obtain a more diverse student body. In this study, pre-college programs such as Science Bound and ISU Engineering Preview Day were mentioned as being influential on a student's decision to study engineering at ISU. However, a more in-depth evaluation of these programs could yield information on how these programs promote the success of Latina/o students. Exploring how many students participate in such programming and how many actually enroll in college can alert scholars to the influence such programs have on getting students to enroll in college. If higher education researchers want to gain a greater understanding of student retention and persistence, more information about the pre-college journeys of Latina/o students is needed. Additionally, pre-college programs have the power to inspire. Researchers can ask how pre-college programs inspire students to study, especially in institutions where they are a small minority and face many obstacles to achieving success.

Effects of Pedagogy on Student Persistence

A lack of diverse and inclusive teaching methods diminished the student experience in engineering classrooms. Researchers should study the effects that content delivery (pedagogy) inside the classroom has on student persistence. Are students being pushed out of engineering and science classrooms unknowingly by professors who resort to non-engaging and traditional teaching methods based on passive learning and competition? Data from this study (presented in chapter 1) suggested that students are in fact leaving their engineering program at some point during their college experience. Future studies on how a student is

taught and the effect pedagogical styles have on persistence and retention warrant attention. Through an increased understanding of the interactions between professors and students inside the classroom, higher education researchers can open a new window into the journey of Latina/o student engineers and scientists. It may appear to be oversimplified, but if a student is not engaged in class work then how can higher education faculty and administrators expect them to stay in college? Future research on pedagogical approaches in engineering and science can help current professors and researchers create classroom environments that allow students to achieve success.

The Latina/o Experience in a Hispanic Serving Institution (HSI)

Hispanic Serving Institutions (HSIs) can offer valuable data on Latina/o students. Unlike ISU, a predominantly white institution, HSI universities can show an entirely different perspective on Latina/o student persistence. Additionally, HSI universities have additional funding sources available for creating success among Latina/o students. What role do specific funding sources (federal funding and government and private grants) play in the persistence of Latina/o students in HSI universities, especially in STEM fields of study? Future research addressing these questions could then be compared to institutions like ISU. This would provide researchers with a greater understanding of how the Latina/o student experience differs at other universities and is not the same everywhere.

More Qualitative Inquiry

More qualitative inquiry needs to be conducted in order to hear the voice of the Latina/o student population. While generalizing research results is important in higher education, qualitative inquiry provides an understanding of the human element of a human issue like education. Education should not only be viewed as an institution best understood

through spreadsheets and percentages, but also through the understanding of the lived experiences that are best examined through qualitative research. Qualitative methods such as one-on-one interviews and focus group interviews help provide a foundation of dialogue and discussion which is important in developing ways to increase the achievement of Latina/o students who decide to study in science and technology.

Conclusion

Hearing the Experiences of Latina/os

The Latina/o population in higher education has seen steady growth over the past several decades. Latina/os were and continue to be faced with many barriers to achieving success through college education. However, the higher education community must be careful to not overlook the positive experiences of Latina/o students like those portrayed in this investigation. Examining positive influences on student persistence and the experiences that promote growth can inform practitioners, administrators, and policy makers just as much as examining the factors that deter student achievement. Now that the Latina/o student population is beginning to see barriers to college education lifted, higher education personnel must continue to examine the persistence of these students once they reach the college campus. It is through continued growth in understanding and awareness that true change is possible. The higher education community can benefit greatly from becoming more inclusive and more successful in graduating its Latina/o scholars.

This study shed light on the successful persistence experiences (navigating the College of Engineering toward a college degree) of a group of Latina/o engineering students at the predominantly white College of Engineering at ISU. In his essay, *Dean-Based Leadership* (2006), Mark W. Clark pointed to the need for more qualitative data when

making decisions about diversity in higher education. Clark asserted that research on understanding students of color in higher education that is directed toward senior administrators in universities focused heavily on quantitative data intended to increase structural diversity (i.e., the amount of different racial and ethnic groups on any given campus) in the university as a method to augment student success. Clark argued that currently student experiences (qualitative data) are secondary to quantitative data on students of color. Clark further argues that because of the diverse experiences of students of color in college, the quality of their experiences and the understanding of their journey is a more important indicator of success that just numbers and enrollment data (Clark, 2006). It is important that, like this study, researchers continue to document the academic and social experiences of Latina/o college students. If higher education institutions are to increase the academic success of Latina/os in colleges and universities, they must focus not only on the numbers of students but also on the experiences of different groups with different academic conditions. College is a collaborative and personal process, and many factors determine a student's development while in college. A human element is added to the collection of data when higher education administrators hear and appreciate the Latina/o student voices. Higher education personnel can learn from the positive journeys experienced by the students and understand what factors allowed these students to succeed in engineering.

Furthermore, this research showed that Latina/o students can succeed in a somewhat oppressive environment, but that students remain vulnerable to barriers that may hinder their academic success. If higher education institutions expect to see increases in the representation of Latina/o students in engineering, they must change the way they create validating and supportive college environments where Latina/o students can thrive as

students of color. Latina/o students will continue to knock at the door of engineering programs and attempt to liberate themselves through education. It is the institutions' responsibility to shape their experiences positively and support these students to graduation. Only then will we see an increased representation of Latina/o students in the engineering sector of our increasingly interconnected world.

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APPENDIX A

Focus Group Interview Protocol

1. Why did you select the engineering program at ISU? Thinking of what you know now, would you make the same decision? Why or why not? **(Probe for things such as academic program reputation, faculty, student life, scholarship/financial aid, university size, and pre-college programs).**
   (Survey 2-Q4)

2. Think about before you enrolled in engineering at ISU. Who or what helped you enroll in engineering? **(Probe for how well high school prepared the student for engineering in college, what family support existed, what family financial contribution existed, and receipt of student loans/grants/scholarships). (Survey 2-Q5, 3-Q1,2,5,6)**

3. What are some of the most positive aspects your engineering program at ISU? What have been some of the most problematic aspects?

4. Think about the faculty, staff, administration, and programs during your time at ISU. Can you identify any person or special program that has helped you succeed during your time here at ISU? Explain the positive influence this person/program has had on you? **(Probe for specific engineering people, and specific non-engineering people at ISU, also how well the student feels they belong to the ISU community).**
   (Survey 4-Q4)

5. Think about the faculty, staff, administration, and programs during your time at ISU. Can you identify any person or special program that has made it difficult for you to succeed during your time here at ISU? Explain the negative influence this person/program has had on you? **(Probe for specific engineering people, and specific non-engineering people at ISU, also probe for how likely it is that the student will stay in college, or how likely it is that they will change their major).**
   (Survey 4-Q2,3)

6. In your own words and opinion, why do some people like you succeed in engineering and why do some not succeed?

7. What have been the most important things you have learned in your engineering program at ISU? **(Probe for cognitive and non-cognitive components).**

8. If you were in charge of the College of Engineering at ISU what would you do to help other Latino students like you succeed during their time as an undergraduate at ISU?

APPENDIX B

Latina/o Persistence Survey (Spring 2007)

Section 1: Demographics

1. Gender identity:
    ____Male ____Female ____Transgender
2. Ethnicity (Check all that apply)
    ____Chicano
    ____Mexican-American
    ____Mexican
    ____Puerto Rican
    ____Cuban
    ____Salvadorian
    ____Spanish
    ____Other, please indicate_____
4. Your income level
    ____Less than $40,000/year
    ____$40,001- $60,000/year
    ____$60,001-$80,000/year
    ____$80,001-$100,000/year
    ____Over $100,001/year
5. Your family's/parent's income level
    ____Less than $40,000/year
    ____$40,001- $60,000/year
    ____$60,001-$80,000/year
    ____$80,001-$100,000/year
    ____Over $100,001/year
6. What is the highest level of formal education your parents have completed?
    Parent 1 (please circle one): Mother Father
        ____Does not have a high school diploma
        ____High school diploma
        ____Associate's degree/professional certification
        ____Bachelor's degree
        ____Master's degree
        ____Doctoral degree
    Parent 2 (please circle one): Mother Father
        ____Does not have a high school diploma
        ____High school diploma
        ____Associate's degree/professional certification
        ____Bachelor's degree
        ____Master's degree
        ____Doctoral degree

7. What is your major concentration in engineering?
    ____Aerospace
    ____Agricultural & Bio-systems
    ____Chemical & Biological
    ____Civil/Environmental
    ____Computer
    ____Construction
    ____Electrical
    ____Industrial/Manufacturing
    ____Materials
    ____Mechanical
    ____Software
8. What is your academic classification at ISU?
    ____First-year/Freshman
    ____Sophomore
    ____Junior
    ____Senior
9. How many years have you been in college?
    ____Less than 1 year
    ____1
    ____2
    ____3
    ____4
    ____5
    ____6
    ____more than 6, please write in the specific year_____
10. How many years have you been at ISU?
    ____Less than 1 year
    ____1
    ____2
    ____3
    ____4
    ____5
    ____6
    ____more than 6, please write in the specific year_____
11. Are you a transfer student? If yes, where did you go to college before ISU?
    ____Yes, where?_____
    ____No
12. What is your current student status at ISU?
    ____Part-time student, how many units are you taking?_____
    ____Full-time student, how many units are you taking?_____

Section 2:Pre-College Experiences

1. What was your high school GPA?_____
2. How many math classes did you take in high school?_____

3. How many science classes did you take in high school?_____
4. Why did you choose to come to Iowa State University? (Check all that apply).
    _____Academic program reputation
    _____Professors
    _____Student organizations
    _____Student support services and programs
    _____I received a scholarship
    _____I was part of a pre-college program like Upward Bound or Science Bound
    _____Location
    _____Size
    _____Diversity
5. To what extent do you believe your high school prepared you to succeed in your engineering program at ISU?
    _____Extremely well prepared
    _____Prepared
    _____Somewhat prepared
    _____Unprepared
    _____Poorly prepared

Section 3: Family and Lifestyle

1. How supportive was your family about your decision to go to college?
    ____Very supportive
    ____Supportive
    ____Somewhat supportive
    ____Unsupportive
    ____Very unsupportive
2. Does your family currently help you pay for college?
    ____Yes
    ____No
3. What current responsibilities do you have in your family? (Check all that apply).
    ____I take care of my own children
    ____I take care of someone else's children
    ____I take care of a parent or grandparent
    ____I work full-time
    ____I work part-time
    ____I take care of a sick/ill family member
    ____I have to pay for daycare services
4. Do you have to commute from a city other than Ames to attend ISU?
    ____Yes, from where and how many miles_____
    ____No
5. Do you currently have to take out student loans to pay for college?
    ____Yes
    ____No

6. Do you receive financial aid in the form of grants or scholarships?
    ____Yes
    ____No

7. Are you the first in your immediate family to attend college?
    ____Yes
    ____No

Section 4: College Experiences at ISU

1. What is your current cumulative GPA at ISU?_____
2. How likely is it that you will stay in college and complete your engineering degree?
    ____Very likely
    ____Likely
    ____Somewhat likely
    ____Unlikely
    ____Very unlikely
3. How likely is it that you will switch your major?
    ____Very likely
    ____Likely
    ____Somewhat likely
    ____Unlikely
    ____Very unlikely
4. How well do you believe you fit in or belong to the ISU community?
    ____I feel that I belong here
    ____I sometimes feel that I belong here
    ____I feel left out at ISU
5. How long do you believe it will take you to finish your undergraduate degree in engineering?
    ____4 years
    ____5 years
    ____6 years
    ____7 years
    ____8 years
    ____more than 8 years