CREATING A CLIMATE FOR SUCCESS?: DOES RACIAL COMPOSITION MATTER FOR UNDERGRADUATE LATINA/O STEM RETENTION?

BY

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DISSERTATION

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Abstract

As the United States population approaches a minority majority, the need to address educational inequities is intensified, especially for Latina/o students, who are among the fastest growing ethnic minority group across the United States and at four-year colleges and universities. Concerns for national security, human capital development, innovation, and equity also demand increased representation of domestic under-represented groups in science, technology, engineering, and mathematics (STEM) fields. This quantitative dissertation comprises three studies that are informed by six years of semester-by-semester student-level data from six large, public, doctoral granting, research-intensive universities located in the Midwest and Mid-Atlantic regions. First, I examine differences in STEM degree attainment among Latinos at the intersections of Latino ethnicity, gender, and socioeconomic status and find evidence for the need to target STEM intervention efforts for Latinos by gender. Second, I explore the relationship between structural diversity and Latina/o STEM student persistence to degree and find a modest and negative relationship between increases in Latino racial composition at the cohort level and student departure from the university; however, no differences were observed for STEM departure or other measures of structural diversity. Third, I test whether students' high school racial context serves as a moderating factor for STEM and college departure and find no evidence that students' high school racial context moderates the relationship between cohort-racial composition and college departure or departure from STEM.

Keywords: Latinos, Higher Education, STEM, Racial Composition

Para mi Familia

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Chapter 1

Introduction

Latinos, at 17.3% of the total population, are currently the largest racial minority group in the United States (U.S. Census Bureau, 2014). The Pew Hispanic Center reports that Latinos account for the largest share of the United States' population growth, increasing by 55.4% from 2000-2011, which is mainly attributed to domestic births. This rate of growth is expected to persist, given the young age distribution of Latinos when compared to the nation as a whole. In 2010, approximately 34% of Latinos were under the age of 18, and the proportion of children under the age of five for Mexican and Puerto Rican groups, the two largest Latino subgroups, was almost double that of non-Latino Whites (see Table 1). These trends suggest that Latino fertility is high when compared to other groups and will undoubtedly continue to impact the racial demographics of our school age population.

Table 1

Percent of Population Under 5 and 18 Years, 18-64 Years and 65 Years and Older for Latinos by Subgroup and for White Non-Latinos, 2014

	Under 5 Years (%)	Under 18 Years Old (%)	18-64 Years Old (%)	65 Years Old and Older (%)
Total	6.5	24.0	51.1	13.0
Hispanic	10.1	33.9	60.6	5.5
Non-Hispanic, White	5.2	20.2	63.5	16.4
Mexican	11.1	36.8	58.8	4.5
Puerto Rican	9.6	33.4	59.8	6.7
Cuban	5.7	21.1	62.0	16.9
Central American	8.2	25.4	70.7	3.9
South American	6.3	22.6	69.5	7.9
Other Hispanic	8.6	28.7	65.2	6.1

Note. Population data from U.S. Census Bureau (2015).

In addition to overall projected growth, Latinos are increasingly calling non-traditional Latino destinations home across the United States. For example, in 2000, 81% of Latinos were concentrated in nine states (Chapa & De La Rosa, 2004), but in 2010 these same states would only house 77% of the Latino population (Rincón, De La Rosa, & Chapa, 2016). During this same time period, Southern states including South Carolina, Alabama, Tennessee, Kentucky, Arkansas, North Carolina, and Mississippi more than doubled their Latino population (Rincón, De La Rosa, & Chapa, 2016). Similarly, North Carolina, Georgia, Oklahoma, Nevada, Nebraska, Washington, Oregon, and Kansas each claimed a sizeable Latino population (approximately 10% of their state's population) (Rincón, De La Rosa, & Chapa, 2016). At this rate, these states will disrupt our understanding of where we would expect Latinos to reside. Further, changes in Latino destinations will have strong implications for schools in emerging Latino communities, specifically in terms of capacity (Beck & Allexsaht-Snider, 2002; Villenas, 2002), concentrated poverty (Hamann, Wortham, & Murillo, 2002; Villenas, 2002), culturally relevant pedagogy (Grady, 2002), college-going rates (Contreras, 2005; Contreras, 2011), and linguistic differences (Beck & Allexsaht-Snider, 2002; Contreras, 2011; Villenas, 2002; Wortham, 2002). Thus, examination of the educational experiences of Latinos outside of traditional Latino communities is necessary to better understand how Latinos are being incorporated into non-traditional Latino destinations, whether their educational needs are being met, and how we can target efforts for greater impact.

Geographic Context

The six universities in this study are located in six states in the Mid-West and Mid-Atlantic regions. The Latino population in these states ranges from a low of 3% to a high of 16% (U.S. Census Bureau, 2013). According to the U.S. Census Bureau (2013), five of these states experienced more than a 50% increase in their Latino population between 2000 and 2010 (ranging from a low of 32.5% to a high of 84%), and in all but one state, Latinos of Mexican origin are the largest subgroup, ranging from 18% to 80% of the states' Latino population. Approximately 41-67% native born Latinos in these states speak more than one language and an average of 73% of these states' Latino population live at or below the poverty line.

Three-year population estimates depict stark differences in educational attainment for Latinos residing in these six states when compared to the states' average educational attainment. In these states, 17.6% (a range of 15-22%) of the total population age 25 and older held a bachelor's degree (U.S. Census Bureau, 2011-2013). Comparatively, 8.9% of Latinos age 25 and older held a bachelor's degree (a range of 8-10%). Even more striking is the number of Latinos within this age range with less than a ninth grade education (20.5%) and less than a high school diploma (15.3%), when compared to the overall states' population with less than a ninth grade education (4%) and less than a high school education (7.2%). Chapa (2012) attributes the overrepresentation of Latinos holding less than a high school diploma to differences in educational attainment for Latino immigrants who come from countries where compulsory education ends sooner than high school. Still, native born Latino high school completion rates continue to be an issue of concern.

The demographic shift towards what some call a minority-majority, emerging Latino destinations, and Latinos' youthful age distribution will impact all levels of our education system. Of interest is the educational attainment of this group, given that over a third of the total Latino population over the age of 25 holds less than a high school diploma (U.S. Census Bureau, 2013). If this educational trend continues, a large sector of society will be unable to fully participate in an economy that increasingly requires some form of postsecondary education.

Postsecondary Participation

Recognizing the growth in global competition and the need to invest and cultivate the human capital among domestic students, President Obama challenged America with meeting his 2020 College Completion Goal of increasing the United States' degree attainment rate from 40 to 60% (Obama, 2009). The President stated, "America cannot lead in the 21st century unless we have the best educated, most competitive workforce in the world." Obama's call to increase college completions was reinforced by projections showing that 60% of all new jobs in 2018 will require some form of postsecondary schooling or training (Carnevale, Smith, & Melton, 2011). Of the projected growth, the STEM sector was identified as being the second largest, with two-thirds of all STEM jobs requiring at least a bachelor's degree.

Obama's 2020 College Completion Goal comes at a time when colleges are increasingly enrolling a more racially diverse student body, with the largest growth among students of color. From 2000-2010, the Latino share of postsecondary enrollment increased by 30%, while non-Latino Whites experienced a 10% decline (see Table 2). Since 1990, Latinos have tripled their overall representation in postsecondary school, while the proportion of non-Latino Whites attending college has consistently declined. Postsecondary enrollments alone, however, can be misleading without disaggregating by institution type. Indeed, a closer look demonstrates that college-going Latinos who attend public postsecondary institutions are concentrated at public two-year colleges (60.0 %), the highest among all racial/ethnic groups in 2010, and they are among the least likely to enroll at public four-year colleges (see Table 3).

Table 2

Total Undergraduate Fall Enrollment by Race, 1990, 2000, and 2010 (In Thousands)

	1990		2000		2010		2000-2010
	N	%	N	%	N	%	% Change
Total	13,819	100	15,312	100	21,016	100	0
Non-Hispanic, White	10,723	78	10,462	68	12,723	61	-10
Total Minority	2,705	20	4,322	28	7,584	36	29
Non-Hispanic, Black	1,247	9	1,730	11	3,039	15	36
Hispanic	782	6	1,462	10	2,741	13	30
Asian or Pacific Islander	572	4	978	6	1,282	6	0
American Indian, Alaskan Native	103	1	151	1	196.4	1	0
Nonresident Alien	392	3	529	4	710	3	-25

Note. Enrollment data from Chapa & De La Rosa (2004) and U.S. Department of Education (2011).

Table 3

Public Undergraduate Enrollment by Level of Institution and Race, Fall 2010 (In Thousands)

	4-year	% Total Enrollment	% Enrollment by Race	2-year	% Total Enrollment	% Enrollment by Race
Total	7,925	100	100	7,218	100	100
White	5,070	64	55	4,117	57	45
Black	913	12	46	1,076	14.9	54
Hispanic	869	11	40	1,288	17.8	60
Asian	522	6.6	54	447	6.2	46

Note. Enrollment data from U.S. Department of Education (2011).

An analysis of college enrollment trends by the Center on Education and the Workforce portrays the growing racial divide in postsecondary education over the last 15 years (Carnevale & Strohl, 2013). The report finds that Black and Latino students have very distinct and unequal postsecondary pathways when compared to their White peers. The path for Black and Latino students leads to a concentration at two-year open-access schools, whereas the path for White students leads to an overrepresentation at selective colleges and universities. These trends also hold for highly qualified Black and Latino students, despite evidence that selective institutions are better resourced and better equipped to graduate students from under-served groups. Carnevale and Strohl observe that “African-American and Hispanic students with above average SAT/ACT scores graduate at a rate of 73% from the top colleges, compared to a graduation rate of 40% at open-access schools” (p. 27).

Highly selective public universities have been associated with an array of societal and individual benefits including increased civic participation, higher earning potential and graduation rates. Bowen and Bok (1998) find that racial minority students who attend these institutions benefit from higher rates of degree completion. In their study, Black graduates went on to earn professional or doctoral degrees at higher rates (five times the national average), had lower rates of unemployment upon graduation, and had wage premiums of 73% and 82% for Black females and males respectively.

In addition to the many benefits associated with attending selective institutions, doctorate granting universities with very high research activities, like the six institutions represented in this study, serve as a pathway to high-return STEM degrees and careers. In 2011, these institutions awarded 38% of all bachelor’s degrees in science and engineering (see Table 4). They also award more than half of all engineering bachelor’s degrees and roughly 40% of all agricultural, biological, earth, mathematics, physical, and social sciences. The capacity to enroll and graduate a large number of students, especially STEM graduates, presents an opportunity for these institutions to contribute to the production of STEM degrees among under-represented populations.

Table 4

Science and Engineering Bachelor's Degrees Awarded to Doctorate Granting Universities with Very High Research Activity, 2011

Degree Type	N	%
All S&E	210,425	38
Agricultural sciences	10,283	45
Biological sciences	37,626	40
Computer sciences	8,193	19
Earth, atmospheric, and ocean sciences	2,023	38
Mathematics	6,682	37
Physical sciences	6,852	36
Psychology	28,402	28
Social sciences	69,114	40
Engineering	41,250	53

Note. Degree data from National Science Foundation (2014).

STEM students who enroll at selective colleges are less likely to declare a STEM major (Bonous-Hammarth, 2000; Engberg & Wolniak, 2013) and persist to degree (Chang, Sharkness, Newman & Hurtado, 2014). In fact, a 100 point increase in a measure of institutional selectivity was associated with a 13% decline in STEM persistence once enrolled. Elliott et al. (1996) find racial differences in STEM persistence to degree at selective universities where Black aspirants abandoned initial STEM interests at higher rates than their peers due to inadequate precollege preparation and ability, measured by students' standardized scores and math and science coursework. Elliott and colleagues posit that these same students may have persisted to degree had they enrolled at a less-selective institution where they would have been more competitive and a better "fit."

Inadequate academic preparation in math and science may contribute to attrition rates among Latino and Black students pursuing STEM at highly selective universities, but selective institutions, including selective public institutions, must examine the ways in which they contribute to the *pushing-out* of students. More troubling is the fact that selective institutions likely enroll the most promising underrepresented STEM students, yet appear less likely to graduate them. By focusing on students' "shortcomings," scholars fail to acknowledge the role that institutions play in the STEM departure puzzle**.**

STEM Trends

Rationales for increasing the numerical representation of under-represented groups in college and within STEM fields go beyond the calls for economic competition and scientific innovation raised by government reports, non-profits and scholars alike. Gaining access to a job sector with high growth and low unemployment rates, coupled with premium salaries (an average of $14,000 extra per year at every education level), has the potential to bridge racial and gender wage gaps, as well as increase socioeconomic mobility for students who hail from some of the most socioeconomically disadvantaged communities (Carnevale et al., 2011). Despite the lucrative potential of STEM degrees, the growth in science and engineering degree attainment shows modest improvements for these under-represented groups. From 2000-2009, undergraduate engineering and science degree attainment increased by 2% among Latino students and 1% for Black students (National Science Board, 2012).

Several reports have examined the disproportionate participation rates in STEM for students of color and find that factors that impact access and persistence in higher education for all fields are exacerbated within STEM.[1] These factors include—but are not limited to—academic preparation, financial aid, institutional type, campus culture and climate, institutional agents, and self-concept (Museus, Palmer, Davis, & Maramba, 2011; Seymour & Hewitt, 1997).

Despite the odds stacked against them, students of color aspire to STEM degrees at rate similar to those of their White peers (Herrera & Hurtado, 2011). Few, however, are able to fulfill their STEM degree aspirations. Seymour and Hewitt (1997) liken the increasing numbers of

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[1] *Rising Above the Gathering Storm, Revisited: Rapidly Approaching Category* 5 (2010), *Expanding Underrepresented Minority Representation: America's Science and Technology Talent at the Crossroads* (2011)

students of color exiting STEM to a revolving door that spins faster as the number entering increases. Native American, Black and Latino students leave science, math, and engineering (SME) majors at double the rate of their non-minority peers (Bonous-Hammarth, 2000). At the intersection of race/ethnicity and gender, Native American, Black and Latino female undergraduate students make up the majority of undergraduate students exiting SME. Women and students of color are less likely to re-enter STEM when compared to male and non-minority students (Griffith, 2010).

National trends depict small gains in Latino STEM degree attainment. In 2011, Latinos received 8% of all math and computer science, engineering, and physical science degrees, and earned only 5% of all agricultural and earth, atmospheric, and ocean sciences degrees (see Table 5). Given differences in Latino participation in STEM subfields, additional research exploring this phenomenon is needed.

Table 5
Earned Bachelor's Science and Engineering Degrees for Hispanics by Field, 2005-2011

Field	2005		2007		2009		2011	
	N	%	N	%	N	%	N	%
Engineering	4,628	7	4,962	7	5,577	8	6,317	8
Agricultural Sciences	710	4	776	4	969	5	1,236	5
Biological Sciences	4,819	7	5,453	7	6,384	7	7,761	8
Earth, Atmospheric, and Ocean Sciences	151	4	135	3	221	5	265	5
Mathematics/ Computer Sciences	4,350	6	3,916	6	3,977	7	4,691	8
Physical Sciences	938	6	1,032	6	1,169	7	1,278	7

Note. Degree data from the National Science Foundation (2014).

Disaggregating among STEM subfields reveals additional Latino concentration. For example, Latinos are better represented in some engineering degrees than others. In 2011, Latinos received 10% of industrial and civil engineering degrees compared to 4% of materials engineering degrees (see Table 6). In fact, the proportion of Latinos receiving degrees in material engineering has actually declined over the years. Within the physical sciences, Latinos obtain a larger proportion of astronomy and chemistry degrees, compared to physics (see Table 7). In oceanography and atmospheric sciences (see Table 8), Latinos experienced slight numerical growth between 2005 and 2011, but, unfortunately, their representation among degree holders remain around five percent nationally. Latinos have obtained a larger share of mathematics degrees, yet the proportion of degrees obtained has remained around six percent between 2005 and 2011 (see Table 9).

Table 6

Earned Engineering Bachelor's Degrees for Hispanics by Field, 2005-2011

Field	2005		2007		2009		2011	
	N	%	N	%	N	%	N	%
Aerospace	139	6	172	6	194	6	217	7
Chemical	333	7	326	6	405	7	478	6
Civil	888	9	1,006	9	1,269	10	1,428	10
Electrical	1,535	7	1,521	8	1,484	9	1,548	9
Industrial	364	9	337	10	428	11	463	11
Materials	59	7	40	4	48	4	50	4
Mechanical	962	6	1,147	7	1,183	7	1,516	8
Other	348	4	413	5	566	6	617	6

Note. Degree data from the National Science Foundation (2014).

Table 7

Earned Physical Science Bachelor's Degrees for Hispanics by Field, 2005-2011

Field	2005		2007		2009		2011	
	N	%	N	%	N	%	N	%
Astronomy	17	5	18	5	21	6	26	7
Chemistry	704	7	748	7	879	7	940	7
Physics	183	4	246	5	235	5	276	5
Other	34	6	20	4	34	5	36	5

Note. Degree data from the National Science Foundation (2014).

Table 8

Earned Earth, Atmospheric, and Ocean Sciences Bachelor's Degrees for Hispanics by Field, 2005-2011

Field	2005		2007		2009		2011	
	N	%	N	%	N	%	N	%
Atmospheric sciences	20	3	18	3	42	6	29	4
Earth sciences	121	4	113	3	172	5	223	5
Oceanography	10	7	4	4	7	5	13	6

Note. Degree data from the National Science Foundation (2014).

Table 9

Earned Computer Science and Mathematics Bachelor's Degrees for Hispanics by Field, 2004-2011

Field	2005		2007		2009		2011	
	N	%	N	%	N	%	N	%
Computer Sciences	3,529	6	2,970	6	2,999	8	3,539	8
Mathematics	821	6	946	6	978	6	1,152	6

Note. Degree data from the National Science Foundation (2014).

At the intersection of Latino ethnicity and gender, we see greater subgroup disparities in STEM participation. Consistently, Latinas pursue degrees in biological, agricultural, social and behavioral sciences at higher rates than their male counterparts (see Table 10). In comparison, Latino males have higher rates of pursuing degrees in engineering, mathematics, statistics, computer sciences, and the physical sciences. In 2012, Latinas were more likely to pursue a degree in biological and agricultural sciences (14.3%) than mathematics, statistics, and computer science degrees (1.4%). Over the years, Latinas have made few gains in their entrance into "high status" STEM fields, with a larger percentage of women pursuing mathematics, statistics, and computer science degrees in 1999 (2%) than in 2012 (1.4%). When compared to their male peers, Latinos were more 3.7 times more likely to pursue mathematics, statistics and computer science degrees when compared to Latinas in 2012. Moreover, the largest gender gap is found in engineering (16 percentage points), one of the few STEM degrees where Latinos have a substantial representation.

Table 10

Percent of Hispanic Freshmen Intending S&E Major by Field and Sex, 1999–2012

		Physical Sciences	Biological/ Agricultural Sciences	Mathematic/ Statistics /Computer Sciences	Social/ Behavioral Sciences	Engineering
1999	Male	1	6.7	8.1	7.1	22.4
	Female	0.7	9.7	2	14.1	3.3
2000	Male	1.4	7.5	8.6	7.9	17.1
	Female	1	7.3	2.1	15.7	2.1
2001	Male	1.4	6.8	8.5	7.9	18.2
	Female	1.1	8.1	1.9	14.6	2.7
2002	Male	1.8	7.2	5.9	8.8	19
	Female	1.5	9.3	1.3	17.3	2.6
2003	Male	2.1	6.3	5.4	8.8	19.2
	Female	1.1	9.6	1.2	17.1	2.9
2004	Male	1.9	8.1	5.1	9	21.2
	Female	1.3	10.9	1.3	16.6	3.3
2005	Male	1.4	6.6	3.5	8	19.9
	Female	1.9	8.7	1.5	12.3	2.6
2006	Male	2.4	9.6	4.3	10.8	14.2
	Female	2	9.6	1	12.1	2.5
2007	Male	1.6	9.1	3.6	9.8	14.7
	Female	2	9.7	1.1	12.3	2.6
2008	Male	2.1	9	3.2	9.3	18.1
	Female	2.1	10.4	1.1	12.8	3.1
2009	Male	2.6	10.9	2.9	11.2	19.6
	Female	2.1	11	1.1	12.8	3.3
2010	Male	2.3	9.7	3.5	10.7	18.2
	Female	2.2	12.4	1.1	13.6	4
2011	Male	2.3	10.9	3.3	10.7	20.9
	Female	2.1	12.8	1.2	14.5	4.2
2012	Male	2.3	10.9	5.2	9.8	20.2
	Female	1.9	14.3	1.4	12	3.9

Note. Degree data from the National Science Foundation (2014).

Purpose of the Study

In light of demographic changes and a need to increase Latino participation in STEM, this quantitative dissertation aims to understand Latino undergraduate participation in STEM at six predominantly White institutions located in the Mid-west and Mid-Atlantic regions. This dissertation includes three studies, each represented by a separate research question, which collectively seek to examine Latino representation in STEM. Cumulatively, these three studies will investigate Latino persistence to STEM degrees.

The first study, presented in Chapter 3, will compare between group movement into and out of STEM fields and the university for Latina/os, Asians, Blacks, and Whites, as well as within group differences for Latino students at the intersections of gender and socioeconomic status. It seeks to answer the following questions:

1. How do the movement patterns between college majors of Latina/o students compare to those of their Asian, Black, and White peers?
    a. How do movement patterns for STEM students differ at the intersections of Latino ethnicity and gender?
    b. How do movement patterns for STEM students differ at the intersections of Latino ethnicity and socioeconomic status?

The second study, presented in chapter 4, addresses the second research question of this dissertation and aims to uncover what role, if any, structural diversity may play in Latino STEM persistence to degree. Specifically, it asks:

2. Does the racial and ethnic composition of STEM subfields (e.g. computer and mathematical sciences, life sciences, physical sciences, social sciences and engineering) impact the probability of Latino student departure from STEM?
    a. How, if at all, does the relationship between racial and ethnic composition of STEM departure differ for Black, Latino and White students?

b. How do the multiple levels of structural diversity, as measured by racial composition, impact Latino students' retention in STEM subfields (e.g. cohort-level, campus-level, and graduate-level)?

The final study, presented in Chapter 5, aims to capture how prior racial contexts impact how students respond to the campus racial climate on campus. It asks:

3. How do Latino student's prior socialization contexts, such as the high school racial context, moderate, if at all, the relationship between structural diversity and student persistence to degree?

Significance of the Study

Demographic shifts showing a growing Latino population across the United States and the limited literature on the Latino experience in STEM higher education position this study to make a critical impact on the academic community. The geographic context of this study (i.e. Mid-Atlantic and Great Lakes) provides a unique contribution as the literature on Latinos is dominated by studies situated in the Southwest and West. Because current population trends suggest that Latinos are increasingly moving to new destinations across the United States, this study makes a unique contribution to the literature by examining the Latino undergraduate experience in the Mid-Atlantic and Midwest region. The investigation of racial composition at the STEM subfield-level is also a unique contribution of this study. Latina/o students face unique obstacles that may limit their participation in STEM including above average high school dropout rates (Fry, 2010), family financial commitments (Seymour & Hewitt, 1997), a concentration at two-year colleges (Kurlaender & Flores, 2005), and a large proportion of first-generation college students (Contreras, 2005). Still, empirical studies exclusively focused on

Latino students in STEM are severely limited (Cole and Espinoza, 2008; Crisp, Nora & Taggart, 2009).

This study has the potential to make an important contribution to stakeholders at the institutional and national level. By examining the movement patterns of Latina/o students in STEM in comparison to other racial/ethnic groups and by gender, we can learn more about the experiences of these students to better inform program and policy efforts. Similarly, much is unknown about what transpires between initial entrance and college completion for Latino college students. Understanding student movement patterns from entrance to completion can provide insight into where students go when they leave STEM and how these patterns differ gender.

In order to better address the low numbers of Latinos in STEM, we must first understand what malleable institutional factors lead to success in STEM for this population. Results from this study have the potential to directly impact admissions policies and practices at the institutional level, particularly at selective public colleges and universities. For example, if this study finds that students who enroll in a STEM field with a large number of students of color are more likely to persist to degree compared to peers enrolled in comparable fields of study with little to no racial diversity, then there will be evidence to support an intervention aimed at increasing the number of racial and ethnic minority students at the subfield. On a national scale, the results of this study can inform affirmative action debates and provide direction to STEM diversity efforts.

Chapter 2

Review of Literature

This literature review focuses on two interrelated areas 1) factors related to student enrollment in STEM and 2) student departure from STEM fields. The departure literature is outlined using Hurtado, Milem, Clayton-Pedersen, and Allen's (1998) campus racial climate framework and emphasizes structural diversity, the primary variable of interest across two of the three studies that make up this dissertation.

Enrolling in STEM

Students who enroll in STEM as college freshman have gone through an intense sorting process in K-12. Engberg and Wolniak (2013) find that high school math and science course taking patterns, along with GPA, were the strongest predictors for choosing to pursue a STEM degree. This may be a result of STEM major admission policies that often require more years of math and science, as well as higher academic credentials for admissions (Riegel-Crumb & King, 2010). The positive impact of pre-college success on enrolling in STEM is well documented in the literature (Bonous-Hammarth, 2000; Chang et al., 2010; Crisp, Nora, Taggart, 2009; Elliott et al., 1996; Griffith, 2010; Herrera & Hurtado, 2011; Palmer, Maramba, & Dancy, 2011; Staniec, 2004). These pre-college variables have also been found to have long-term effects such that a 100 point increase in a combined SAT score leads to a 6% increase in STEM persistence (Chang et al., 2010). Given the strong relationship between pre-college factors on STEM outcomes, it is important to target and cultivate math and science achievement and interests at a young age.

Expressing an early interest in pursuing STEM is related to future math and science course-taking patterns in high school, enrolling in STEM, and persisting to degree (Maltese & Tai, 2011). A promising finding is that students of color aspire to STEM degrees at similar rates as their White peers (Herrera & Hurtado, 2011). As such, the assumption that students of color "are just not interested in STEM" can be discounted and efforts can focus on retaining STEM students who do enroll. All else being equal, Black students have significantly higher odds of selecting a STEM major when compared to their White and Latino peers (Staniec, 2004; Trusty, 2002). One possible explanation is that recent efforts aimed at broadening STEM participation for traditionally underrepresented groups, such as STEM outreach and recruitment programs that provide early exposure to STEM fields, have been successful (Staniec, 2004). Another explanation may be that Black students see the economic potential of a major that is explicitly linked to employment upon graduation (St. John, Hu, Simmons, Carter, & Weber, 2004). STEM careers certainly enjoy a hefty wage premium in the job market, even among STEM students who leave the STEM workforce (Melguizo & Wolniak, 2012); yet, results do not support this finding given that high achieving Black graduates are the least likely to work in technical fields upon graduation.

Several studies also examine the relationship between socioeconomic factors and pursuing STEM. Some scholars argue that socioeconomic status is unrelated to pursuing or earning a STEM degree (Engberg & Wolniak, 2013; Maltese & Tai, 2011), while others argue that higher income students are the least likely to enroll in STEM regardless of parental education (Staniec, 2004). Still, other researchers note the benefits accrued to higher income students. Higher income students persist in STEM at higher rates (Mau, 2003) and are also more likely to enroll in graduate school (Eagan & Newman, 2010). Trusty (2002) finds that Black and Latino males from higher socioeconomic backgrounds pursue science and math degrees at higher rates. Seymour and Hewitt (1997), however, find that social class differences in STEM are the least pronounced for Latino students.

Parental education, another measure of socioeconomic status, is a significant predictor of pursuing a STEM degree for Black (Trent, Nicholson & George-Jackson, 2006) and Latino (Cole & Espinoza, 2008) students. Further, Leslie, McClure and Oaxaca (1998) find that having a parent who works in a STEM field increases a Latino student's chances of entering the physical sciences and engineering by 8% and has a similar effect for Black students entering the biological sciences.

Retention in STEM

Although access to STEM fields has received most of the attention in the past years, retention rates may be a bigger concern. All racial groups experience the most attrition from STEM majors, but students of color make up the majority of students who exit STEM. Native American, Black, and Latino students leave science, math, and engineering (SME) majors at double the rate of their non-minority peers (Bonous-Hammarth, 2000). At the intersection of race and gender, Black women are almost twice as likely to enter STEM as White women (Trusty, 2002) and Latinas are the most likely to leave STEM (Bonous-Hammarth, 2000). Indeed, within group racial differences offer complicated and conflicting experiences for students of color at the intersection of various identities: gender, racial/ethnic, academic, social and scientific (Tate & Linn, 2005). For example, empirical evidence shows that students of color who engage in undergraduate research are more likely to persist in their STEM major and improve their understanding of science concepts (Eagan et al., 2013; Garcia & Hurtado, 2011; Hurtado, Cabrera, Lin, Arellano, and Espinosa, 2009), while female students of color regard this experience as discouraging (Johnson, 2007). Female participants in Johnson's study who sought career advice, support, and meaningful relationships with their research faculty were left unfulfilled, as faculty were often focused on the science aspect of their relationship. As such, students viewed faculty as detached and questioned the genuineness of their relationship.

Both negative and positive college experiences shape a student's decision to continue along or exit the STEM pathway. Given the low retention rates of students of color, it is important to understand how different students respond to institutional and departmental environments. This will be the focus of the next section.

Retention

Tinto's (1975, 1993) theory of academic non-persistence dominates the literature related to college student departure. The premise of his theory is that retention is dependent on a student's ability to academically and socially integrate into the fabric of the university. A major point of contention in Tinto's work is that social integration requires assimilation (Hurtado & Carter, 1997; Rendon, Jalomo, & Nora, 2002), thus the burden to assimilate into the college environment falls disproportionately on students whose cultures and values do not mirror those held by the institution. This critique has produced a line of scholarship that focuses on how students of diverse backgrounds, and primarily students of color, interpret the institution's environment, that is, factors, including institution type, size, selectivity, location, and diversity, that shape the types of social interactions students have on campus and their ability to successfully "integrate" both academically and socially. This line of scholarship attempts to capture the "effect" of institutional variables on student non-persistence. The campus climate literature is one area of research that has grown over the years as Predominantly White Institutions (PWIs) increasingly enroll a more diverse student body.

Campus Racial Climate

Hurtado, Griffin, Arellano and Cuellar (2008) define campus racial climate as “part of the institutional context that includes community members’ attitudes, perceptions, behaviors, and expectations around issues of race, ethnicity and diversity” (p. 205; Hurtado et al., 1998). Campus racial climate (see Figure 1) is shaped by four interconnected constructs including 1) an institution’s historical legacy of inclusion or exclusion; 2) structural diversity; 3) psychological climate; and 4) the behavioral dimension that exist within a larger sociohistorical and government/policy context (Hurtado et al., 1998; Hurtado et al., 2008). Together these external (i.e. sociohistorical and government/policy contexts) and internal (i.e. institutional context) factors shape the racial context of the student experience.

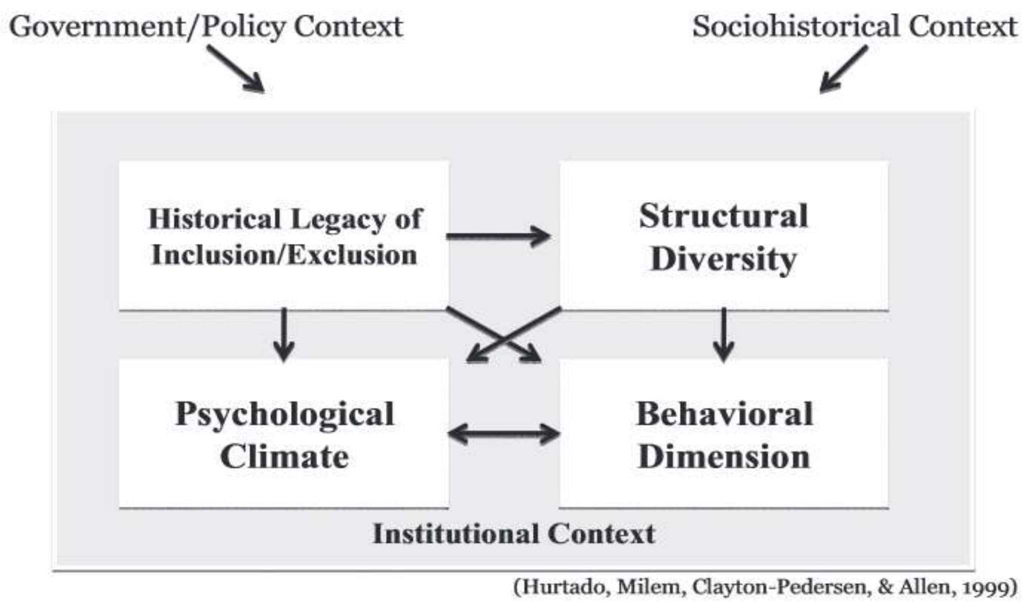

Figure 1. Campus Racial Climate Framework.

While negative perceptions of campus racial climate impact all students’ sense of belonging to campus (Lock, Hurtado, Bowman & Oseguera, 2008), this is especially true for Latino (Hurtado & Carter, 1997) and Black (Cabrera, Nora, Terenzini, Pascarella & Hagedorn, 1999) students. Students of color often experience feelings of isolation and otherness as a result of a hostile campus climate, impacting their academic confidence and adjustment, GPA, sense of belonging, and persistence (Hurtado & Carter, 1997; Rankin & Reason, 2005; Nora & Cabrera, 1996).

As a theoretical framework, campus racial climate is used to understand how students experience the racial aspect (e.g. discrimination and/or racial conflict) of the college environment both socially and academically (Cole & Espinoza, 2008; Hurtado et al., 1998), especially at PWIs. A review of the campus racial climate literature found that most studies have focused on one or two of the four factors that contribute to the campus racial climate on campus, often in response to data limitations (Hurtado et al., 2008). For example, Cole and Espinoza (2008) focus on the behavioral and psychological dimensions of the framework. The four inter-connected dimensions of this framework are outlined in more detail below.

Government & Policy Context. Hurtado and colleagues (1998) define the government and policy context as one of two external forces that impact the racial environment of higher education institutions. This construct comprises federal and state level policies, practices, and programs that intentionally or unintentionally impact postsecondary institutions. As an example, need-based financial aid and affirmative action policies may intentionally seek to increase postsecondary access for low-income and minority populations including women and students of color, whereas immigration policies may unintentionally impact who has access to college by restricting access to in-state tuition and federal and state financial aid for students who do not meet eligibility requirements due to their immigration status.

Indeed, institutions of higher education operate within larger political arenas that have direct consequences on the demographics of their student body. The passage of the Civil Rights Act of 1964 and President Johnson's Executive Order No. 11246 (1965) called higher education institutions to desegregate and created an avenue for racial and ethnic minorities to enroll at PWIs that previously banned their enrollment under *Plessy v. Ferguson* (1896), the landmark U.S. Supreme Court decision that upheld racial segregation of public facilities under the principle of *separate but equal*. More recently, state bans on affirmative action, beginning with California's Prop 209 and Washington's Initiative 200, have restricted access to higher education by eliminating race as one of the many factors used in the college admissions process. Moreover, the indirect impact of anti-affirmative legislation resulted in institutions abandoning special programs aimed at increasing racial diversity due to fear of legal challenge. This resulted in large declines in Black and Latino student enrollment in STEM graduate programs at highly selective research universities (Malcom & Malcom-Piqueux, 2013).

Sociohistorical Context. The second external force that impacts the inner workings of an institution is the sociohistorical context. The sociohistorical context is defined as events or issues that affect how individuals understand race and racial diversity in society (Hurtado et al., 1998). While external to the university, these events impact views of race and race relations on campus. Garces and Jayakumar (2014) identify the broader social context of institutions as one that includes local and state demographics, measures of segregation, and indicators of inequality. Using the *Fisher v. University of Texas* (2013) case as an example, the U.S. Supreme Court case concerning the use of race as a criteria in college admissions, the authors' demonstrate how the University of Texas at Austin failed to achieve a critical mass of racial and ethnic minorities despite having a relatively diverse student body, with 20% Black and Latino student enrollment. The authors argue that UT Austin failed to achieve critical mass due to contextual factors. Garces and Jayakumar (2014) point to the racial composition of the institution, which did not reflect the state's racial composition; the opportunities, or lack thereof, for Black and Latino students to see themselves reflected in leadership roles within the institution, locally and at the state level; lingering effects of state-mandated segregation, and current discriminatory practices against Black and Latinos as factors that impact the ability to create a welcoming climate for Black and Latinos at UT Austin. Finally, they argue that same level or representation (numerically) elsewhere within a different sociohistorical context could be sufficient to foster a critical mass.

Historical Legacy of Exclusion. An institution's legacy of inclusion or exclusion is best understood through the norms embedded in the campus culture, traditions, policies, and mission (Hurtado et al., 2008). These norms are often so entrenched that institutional policies and practices that disproportionately benefit one group at the expense of another go unacknowledged and unchallenged. For example, segregation across and within higher education institutions today is a product of a long history of discrimination along the lines of social class, gender, religion and race (Thelin, 2004). The remnants of exclusionary practices are especially pronounced if we examine enrollment patterns and efforts to ameliorate these inequities for students of color at selective colleges and universities.

Selective public PWIs, the focus of this study, have also been the sites of affirmative action litigation, most recently at the University of Texas at Austin in *Fisher v. University of Texas* (2013). Litigation stems from beliefs that using race as a factor in college admissions violates the equal protection clause of the Fourteenth Amendment. In essence, opponents of affirmative action argue that race conscious admissions result in "reverse" discrimination. Indeed, arguments about which factors should be considered for college admissions are widely debated. Although universities give preferential admissions to students who demonstrate superior athletic abilities and children of alumni, the merit of students admitted through race-conscious policies is the only factor that seems to be up for debate. This is largely due to the fact that White households benefit the most from preferences to athletes and legacy students, thus these preferences serve as a “boost” or a type of “affirmative action” for White students (Espenshade & Chung, 2005). While legacy admissions are mostly practiced at elite private institutions that depend heavily on alumni donations, public universities, including the University of Virginia (University of Virginia, n.d.) and the University of Michigan (University of Michigan, n.d.), also engage in legacy preferences.

The extent to which affirmative action is practiced at colleges and universities is often overestimated. Because affirmative action is only necessary at selective institutions, where institutions receive more applicants than available seats, it is estimated that less than 5% of American colleges and universities practice affirmative action. Still, race-based college admission policies, originally aimed at ameliorating the effects of hundreds of years of discrimination, have not been well received. Indeed, equity-based arguments in defense of the practice of affirmative action at colleges and universities have been overshadowed by arguments that define the need for affirmative action—and by consequence a critical mass of students of color—in relation to its educational benefits for the overall university community (i.e. the White student body). These benefits include preparing students for a diverse workforce, improvement in critical thinking skills, and reducing prejudicial biases (Jakayumar, 2008; Umbach & Kuh, 2006). The danger in centering the rationale for affirmative action as one predicated on the educational benefits of diversity is the possible conclusion that students can achieve this “learning” in the absence of a diverse student body (Umbach & Kuh, 2006).

Culture of Science. The STEM environment offers an added layer of complexity to the institutional context. This is due in part to the low enrollments of students of color and the promotion of a competitive culture that permeates these fields (Seymour & Hewitt, 1997). In

STEM, climates are fostered by impersonal, “complex and rigorous content, competition among students, and pressures to show they belong in the majors they declared” (Palmer et al., 2011, p. 501). Faculty contribute to the competitive culture found in STEM when they discourage students from working together, often in response to the fear of plagiarism (Seymour & Hewitt, 1997). When this happens, students lose out on the benefits of working in groups, including, comprehension and emotional support (Fullilove & Treisman, 1990). Moreover, working alone runs counter to the real world, where professionals often collaborate with others by working in teams. Competitive cultures in STEM, and especially at selective universities, also contribute to the individualistic culture often found in STEM profession, which may run counter to collectivist notions often found in the Latino culture and among Latino students (Cole & Espinoza, 2008; Seymour & Hewitt, 1997).

A unique characteristic of the undergraduate STEM experience is the sequential nature of math and science courses, where courses are meant to build on each other (Seymour & Hewitt, 1997). As a result, any deviation from the structured curriculum can be devastating. Students who mistakenly enroll in the wrong course or who must repeat a course can be set back a whole year. Students describe the experience of retaking a course in engineering as detrimental to obtaining an engineering degree, because “you can never catch up” (p. 94). In addition to a strict course sequence, another characteristic of STEM fields is the “weed-out” or “gatekeeper” courses in which a large amount of material is presented in a short period (Seymour & Hewitt, 1997). The logic behind this practice is that only the most passionate and academically able students will remain, a kind of survival of the fittest, aimed at maintaining the prestige associated with obtaining a STEM degree.

In addition to presenting a large amount of material in a short amount of time, gatekeeper courses often grade on a curve. This practice has been critiqued for disadvantaging students, mainly students of color, first-generation, and low-income students, who may have had less academic preparation as a result of attending lower performing high schools with limited access to upper-level math and science courses, (Riegel-Crumb & King, 2010). Such "average" students who receive low grades may leave STEM within their first academic years due to the weed-out process (Griffith, 2010). Grades and weed-out courses also disproportionately impact women, who are said to struggle with lower self-esteem (Seymour, 1995). Seymour and Hewitt (1997) argue that women may be more sensitive to grades than men, evidenced by trends showing that women leave SME majors despite having higher grades than men who remain in STEM. Recent evidence from a nationally representative study, however, provides conflicting evidence. Griffith (2010) finds that men in STEM may be more sensitive to grades than their female counterparts.

Faculty members can also influence the academic pathways of undergraduate STEM students. University professors who held frequent and flexible office hours and/or were available via email were perceived as being more invested in student learning and their subsequent success (Eagan et al., 2011; Eagan et al., 2012). Students' perceptions of faculty and their commitment to their success is important, especially in large lecture halls where they may feel like a voice in the crowd. When students, especially students of color, find professors unapproachable, they often turn to peers for help (Eagan et al., 2012; Palmer et al., 2011). Finding those peers might be difficult if there are few students of color in the class.

Psychological Dimension. The psychological dimension of the campus racial climate framework aims to capture an individual's *perception* of institutional commitment to diversity issues; racial conflict and discrimination on campus; and feelings of racial isolation (Hurtado et al., 1998; Hurtado et al., 2008). While often measured and reported as "perceived" climate experiences, these perceptions have *real* consequences for students.

Perceptions of climate vary greatly by group membership and prior experiences. Who you are and how you are positioned within the university influences your perceptions and views of an institution and its environment. Students of color are more likely to recognize a hostile and racist environment within a university compared to their White peers and female students are more likely to report sexist environments when compared to their male counterparts on the same campus (Rankin & Reason, 2005). This phenomenon reveals the unearned privilege allotted to students who see themselves reflected in the dominant institutional culture, in particular White male students attending a PWI, who benefit from not having to face, acknowledge or deal with the ramifications of racism and sexism.

In addition to experiencing culture shock at PWIs, students of color in STEM are often among the few students of color on campus or in a department. This tokenized position perpetuates perceptions and stereotypes that students of color were only admitted on the basis of their race to fulfill a quota, and that they are less intelligent than their Asian and White peers (Seymour & Hewitt, 1997). Museus (2008) finds that Black students feel pressure to disconfirm the inferior minority myth. His interviews showed that Black students felt that their non-Black peers perceived them as not being "as smart as them," whether or not peers expressed such opinions. These psychological stressors can impact minoritized students' reluctance to ask questions in class for fear of being seen as the only one who does not understand the material. Students may also avoid answering questions in class because they do not want to provide the wrong answer, thus confirming racial or gender-based stereotypes. As a result, such environments discourage the full academic engagement of students in the classroom and can have consequences for their academic success. Indeed, Black and Latino students who internalize racial stereotypes have diminished self-concept, which undermines their confidence to persist in STEM (Seymour & Hewitt, 1997). These examples point to the ways in which psychological factors, such as self-concept, can be shaped by structural factors like racial composition.

Behavioral Dimension. Hurtado and colleagues (2008) define the behavioral dimension of campus racial climate as the *actual interactions* between and among different groups on campus including informal and formal interactions such as those facilitated in the classroom or through campus-sponsored events. More recently, scholars have examined the frequency and quality of these interactions, especially across racial and ethnic groups (Antonio, 2001).

High School Racial Context. Students from communities with high levels of racial segregation in housing and schools are likely to encounter and interact with someone of a different race or ethnic group for the first time in college. Evidence from studies testing the perpetuation hypothesis (Braddock, 1980; Braddock & Gonzalez, 2010; Stearns, 2010), which states that segregation in early life is related to segregation later in life, would suggest that students who are racially segregated in high school are more prone to experience segregation in college life.

Seymour and Hewitt (1997) find that Black and Latino STEM students who grew up in racially segregated minority neighborhoods and attended minority-majority high schools where their racial or ethnic group was dominant felt uncomfortable on college campuses that lacked a significant representation of their group. At the other extreme, Black STEM students who grew up attending predominantly White schools often related more to White students than other Black students on campus. Antonio's (2004) qualitative study of male student peer groups depicts the ways in which pre-college racial experiences impact subsequent cross-racial experiences in college. A Black male college student in his study who attended an integrated public school demonstrates how racial segregation is perpetuated or normalized based on prior experiences, or as he describes, “It’s how it’s always been for me.” Having a diverse peer group in high school translated into having a diverse peer group in college. Likewise, Latino students who attended predominantly White high schools were less likely to describe adjustment issues related to lower Latino representation at a PWI (Hernandez, 2002).

College Cross-Racial Interactions on Campus. Antonio’s (2001) study of cross-racial peer groups at one institution found that the racial make-up of an institution’s student body affected the racial make-up of a student’s peer group. While the majority of students in his study reported having peer groups that were racially and ethnically mixed, Black students, who made up the smallest racial group at the university (6%), were the most likely to report racially homogenous friendships and the least likely to report diverse friendship groups. Conversely, Asian students, the largest racial minority group at the institution, were the most likely to have a diverse set of close friends. Antonio notes that friendship group diversity shifts based on our definitions of racial and ethnic peer groups. That is, when Asian and Latino pan-ethnic groups are disaggregated the proportion of racial and ethnic homogenous friendships decrease from 30% to 17%. Nonetheless, this study provides strong evidence that the racial composition of a university’s student body impacts the cross-racial interactions a student will have on campus. In STEM, where racial and ethnic minority representation is likely to be minimal, it is likely that racial and ethnic minority peer groups will be more homogenous.

Students of color in STEM report lower levels of class comfort, sense of belonging, and inclusion in group work compared to their White peers (Rincón & George-Jackson, 2011). While the culture of math and science denies the role of race and ethnicity in the classroom, the day-today experiences faced by students who are grossly underrepresented in STEM may prove otherwise. Johnson (2007) captures this experience when she attends a class lecture in STEM with one of her female participants, an African American student:

> She was sitting in an aisle seat; the rest of the row she sat in was empty…at the end of class she told me that whatever row she sits in, she clears it out—no one will sit within five or six seats of her. She explained that she used to sit in the sixth row, all by herself. Recently she had moved up to the fourth row, which had previously had habitual occupants. Now, as I saw for myself when I looked around, the sixth row held a number of students and the fourth row was empty (Johnson, 2007, p. 817).

This documented experience alone would have made Johnson's study compelling, yet several students provided similar accounts. Moreover, these isolating experiences in lecture halls translated into the four students of color in the class always working together, not out of choice, but because no other students would work with them.

Of concern is the finding that students most at risk of leaving STEM due to negative racial experiences are those who aspire to make theoretical contributions to science and seek to find medical cures (Chang et al., 2011). The opposite was true of similar students who were less likely to experience negative climates. These findings are of particular importance because students of color in STEM have a strong affinity to giving back to their communities. Latino students, in particular, have the strongest predilection to serve and repay (Seymour & Hewitt, 1997).

When faculty and peers alike deny the existence of gender and race in the classroom, they silence and render invisible the factors (i.e. racism and sexism) that likely discourage women and students of color from persisting in STEM. Universities, departments and faculty have a responsibility to promote inclusive climates for all students. By assessing the climate experiences of students, administrators can play a hands-on role in deconstructing conditions that promote competitiveness and individualism and make the learning environment more conducive for all students' learning.

Peers. Peers offer an equally important source of support outside the classroom. Peer groups foster academic engagement, safe climates, positive self-concept, work-life balance, social support, and reinforcement of STEM aspirations (Palmer, Maramba, & Dancy, 2011). Beyond offering a safe haven, same-race peer groups may allow students to connect through a shared experience at PWIs, one characterized by a common consciousness of racism on a college campus. African American males in particular often form same-race peer groups as a "matter of survival" (Antonio, 2004). Students who have a hard time finding support in STEM often carry the burden of learning in isolation. Students of color interviewed by Palmer et al. (2011) spoke to the challenges of fitting in or being able to find a study group. Students who did find a study group, often composed of other students of color, viewed their peer group as a family away from home.

Tate and Linn (2005) highlight the challenges faced by students enrolled in STEM programs with little diversity. Students of color often describe an academic group separate from their social group, where the former reflects the demographics of students enrolled in STEM and the latter reflects their own ethnic background, a burden that racial majority students do not carry. This finding is especially relevant for Latino students, given the literature showing the importance of family support and affirmation, especially as it relates to educational success (Gloria, Castellanos, Lopez, & Rosales, 2005). In fact, Latino STEM students have been found to view their Latino peers as members of their extended family (Seymour & Hewitt, 1997).

Conversely, students who are isolated in STEM and are unable to find an ethnic peer group that provides cultural, social and academic support may seek support outside of their major where Latinos are better represented, which can also be a strong incentive to switch majors. Creating community outside of STEM may explain the unexpected negative relationship Cole and Espinoza (2008) identified between studying with other students and attending diversity functions on Latino STEM students' academic performance. The authors speculate that this negative relationship may also be related to time on task. In comparison to Latinos, Black STEM students exhibited more independence and were less likely to depend on other peers for help. Students who did seek help were more apt to seek out tutors and teaching assistants for help (Seymour & Hewitt, 1997).

Student Organizations. Students who join a STEM organization during their first year of college increased their rate of persistence to STEM degrees by 150% (Chang et al., 2010; Chang et al., 2011). These results are due to the many opportunities available to members of such organizations. Specifically, engaging in academically-based student organizations leads to increased interactions with faculty, professional development opportunities, and peer support networks (Eagan et al., 2011; Hurtado et al., 2011). Where faculty of color are few, as in STEM majors, peer mentorship allows students to bond over shared experiences and goals and has the potential for older students to serve as role models who have successfully navigated through STEM (Cole & Espinoza, 2008).

A common theme among successful minority students in STEM was their involvement in ethnic-based STEM organizations (Palmer et al., 2011). These organizations provided a space where students could take on leadership positions; meet and network with other students like themselves; discuss career options; engage in hands-on opportunities (e.g. attend conferences, workshops, participate in research) and meet cultural/personal needs (Hurtado et al., 2011; Tate & Linn, 2005). More importantly, students of color report feeling more comfortable within their major after joining ethnic-based STEM organizations because they feel that they can *be themselves* [emphasis added] (Palmer et al., 2011). As such, peer groups are important for fostering safe climates for students of color. The absence of these groups, especially for populations who encounter discrimination and alienation, may be detrimental to the success of students of color and undermine efforts to make STEM more inclusive.

***Structural Diversity*.** Hurtado and colleagues (2008) describe structural diversity as the "first step" that must be taken in fostering a positive climate on campus. Given that the four institutional factors—historical legacy of exclusion, structural diversity, psychological climate and behavioral dimension—are interconnected, the presence of a large number of students of color on campus has the *potential* to influence both peer and faculty cross-racial interactions, as well as perceptions of intergroup relations. However, Hurtado and colleagues (2008) warn that the act of increasing racial diversity alone will not by itself create a more positive climate, because structural diversity is "necessary, but not sufficient" to achieving a more hospitable environment for students of color (p. 207). Therefore, the possibility of increased intergroup contact says nothing about the *actual* quality of these experiences or whether they are positive. The important role of structural diversity on institutional climate has been the focus of empirical studies seeking to assess the relationship between campus climates broadly on a variety of educational outcomes.

The structural diversity within STEM departments also influences the racial climates that both White and students of color perceive, with students of color experiencing a more positive racial climate as their racial group becomes more visible on campus (Seymour & Hewitt, 1997).

At the same time, racial diversity on a college campus is associated with increased negative feelings and resentment towards non-White peers by White males (Cabrera, 2014). Much of the anger expressed by students was directed at students who were *assumed* to benefit from affirmative action policies, even in the absence of such policies.

Similar to Cabrera's findings that xenophobia is often triggered in response to an increase in racial diversity, Seymour and Hewitt (1997) find a comparable trend in STEM where White students express increased feelings of intolerance towards racial minority groups as their presence in the population increased. This raises a limitation within the campus racial climate framework that I seek to address in this study: the ability to capture climates that are embedded within the larger college campus, including climates found in particular fields. In line with research that examines issues of climate within STEM departments (Etzkowitz, Kemelgor, Neuschatz, Uzzi, & Alonzo, 1994; Griffith, 2010, Rincón & George-Jackson, 2011, Sax, 1996), my study focuses on the unique contributions of racial diversity within STEM subfields. This focus aims to address the potential of student "disengagement at the classroom level [that] has relatively more unavoidable consequences for students, whereas at the campus level, students can sometimes retreat or create counterspaces to overcome harms of stereotypes or isolation" (Garces & Jayakumar, 2014, pp. 118).

Composition Studies. As higher education institutions enroll a more diverse student body, in an attempt to desegregate PWIs, scholars have responded by capturing how the mere presence of racial diversity impacts both majority and minority students' educational outcomes. Allport's (1954) influential intergroup contact theory has framed the majority of compositional studies that seek to examine how institutions may facilitate integration on campus once desegregated. Allport argues that an increase in cross-racial group interactions will result in improved relations, in this case race relations, under the following four conditions: 1) equal status among groups, 2) common goals, 3) intergroup cooperation, and 4) institutional support. Whether these four conditions can be met at PWIs is up for debate.

The presence of racial and ethnic minority students is an important and unique factor to consider when addressing racial and ethnic disparities in STEM (Seymour & Hewitt, 1997). Ethnic isolation and perceptions of racism in STEM are found to vary based on each racial groups' representation on campus and, I would argue, within their more proximal environments—STEM fields. Higher education scholars have taken many different approaches to measure structural diversity (see Table 11). Some scholars have looked at student body composition at the campus level (Denson & Chang, 2008; Hagedorn, 2007; Umbach & Kuh, 2006), while others have focused on structural diversity by field (Etzokowitz et. al., 1994; Griffith, 2010; Sax, 1996). Sax (1996) and Griffith (2010) operationalized structural diversity as a proportion, while others argue for the need to "operationalize diversity by calculating the range, variability and homogeneity of the racial composition of the student body at each institution" (Chang, 1996, p. 63). Overall, most studies examine the relationship that structural diversity and the potential for interacting with someone of another race and ethnicity has on a variety of educational outcomes (Antonio, 2004; Denson & Chang, 2008; Umbach & Kuh, 2006). A lesser number of these studies have examined how structural diversity impacts minority groups' student outcomes (Etzokowitz et. al., 1994; Griffith, 2010; Hagedorn, 2007; Sax, 1996).

Table 11.

Critical Mass Studies

Author	**Year**	**Operationalization Composition**	**Group**	**Finding**
Etzkowitz, Kemelgor, Neuschatz, Uzzi, and Alonzo	1994	15% female faculty	Women	A critical mass was associated with increased feelings of inclusion, support and comfort and fewer experiences of overt sexism for female students pursuing STEM doctorates. Women were still isolated within subfields and male-dominated research teams. Authors observed a "paradox of critical mass," where the older generation of female faculty conformed and prescribed to the "male model of doing science," while a younger generation of both male and female faculty sought to change the culture of STEM.
Sax	1996	Proportion of degrees awarded to women in each field at each institution using Integrated Postsecondary Education Data System (IPEDS).	Women	The positive effect on student grades associated with an increase in the proportion of women in a major is mediated by the college environment, major field, and student characteristics.
Antonio	2004	Best friends were rated on a four-point scale where peer groups were grouped as "homogenous," "predominantly one race," "majority one race," and "no majority."	Students of Color	Results from the study suggest that belonging to diverse peer groups is associated with enhanced self-confidence and educational aspirations for students of color, and lower self-confidence and educational aspirations for white students.
Umbach and Kuh	2006	Structural diversity variable represents the probability that a student will interact with a student from another race by including all five racial/ethnic groups in a single equation.	Students of Color	Students attending small liberal arts colleges are more likely than their peers at other colleges to report larger gains in understanding of diversity issues and engaging in diversity-related activities.

Table 11.
Critical Mass Studies (cont.)

Hagedorn	2007	The number of Latinos per campus divided by the total campus population. These proportions were sorted into three categories: Latinos are more than 50% of population; Latinos are 30-50% of the population; and Latinos comprise between 20-30% of the student population.	Latinos	Results support the positive and modest association between increased Latino representation and student success.
Denson and Chang	2008	The institution's combined percentage of students of color	Students of Color	Results suggest that there is no evidence for the unique contribution of structural diversity to self-efficacy, general academic skills, and racial-cultural engagements when cross-racial interactions and curricular diversity are accounted for.
Griffith	2010	The average percent of STEM undergraduate racial minority students within the first two years of college, normalized by the percent of minority students across all majors and the average percent of STEM undergraduate female students within the first two years of college, normalized by the percent of female students across all majors.	Women, Students of Color	Undergraduate racial and gender composition variables are not significant predictors of student persistence. Female and racial minority measures of graduate composition in STEM, however, are positively and significantly related to undergraduate female and racial minority undergraduate persistence to degree.

To capture the educational benefits (e.g. self-efficacy, general academic skills, racial-cultural engagement) associated with racial diversity, Denson and Chang (2008) used data from the Cooperative Institutional Research Program to assess the unique contribution of curricular diversity, cross-racial interaction and structural diversity. The structural diversity variable was operationalized as an institution's combined percentage of students of color. Results from the study suggest that there is no unique contribution of structural diversity to the study's outcomes: self-efficacy, general academic skills, and racial-cultural engagements. The authors argue that the impact of structural diversity may be captured in other diversity measures, including cross-racial interactions and curricular diversity, because institutions with larger proportions of students of color are also more likely to have a student body that engages in higher levels of cross-racial interaction and curricular diversity. This finding lends evidence to the inter-related nature of structural diversity and the behavioral dimension of the campus racial climate framework.

In 1996, Linda Sax tested Kanter's theory of "tokenism," which posits that a *critical mass* of minoritized groups is necessary to avoid their heightened visibility and marginalization. Studying women in STEM majors, Sax assessed the "effect" of gender composition within those majors on six different outcomes for women in STEM: college grades, academic self-concept, mathematical self-concept, social self-concept, satisfaction with major, and persistence in major. She constructed her primary independent variable of interest using IPEDS data, where *critical mass* was operationalized as the proportion of degrees awarded to women in each field at each institution. Her regression models used Astin's input-environment-outcome (I-E-O) method of entering variables in a series of blocks: 1) input, 2) environment, 3) major, 4) proportion of women, 5) student behaviors, and 6) student perceptions. Sax's results suggest that there is a positive relationship between an increase in the proportion of women in a major and student grades. However, this relationship is mediated by the college environment, major field, and student characteristics. That is, the background of the women who enter STEM and the experiences they have within their majors account for the positive relationship between college grades and the proportion of women in the major. No relationship was observed between STEM persistence and the proportion of women in each major. Two considerations limit the interpretation and generalizability of Sax's study: 1) calculating women's composition in STEM as the proportion of degrees awarded to women in STEM underestimates the initial composition of women who enter STEM fields and 2) the data from the Cooperative Institutional Research Program that informs this study includes a large number of small liberal arts colleges, institutions that produce a small proportion of STEM degrees and are, thus, less likely to capture the various institutional factors found at large public universities that inform the STEM environment: large lecture halls, impersonal relationships with faculty, curved-grading, and weed-out courses.

Through qualitative interviews, Etzkowitz, Kemelgor, Neuschatz, Uzzi, and Alonzo (1994) studied 30 academic departments across five STEM disciplines to explore whether a *critical mass* of female faculty within STEM departments was related to changes in doctoral student graduation rates. Results from the study indicate that for female students pursuing STEM doctorates a critical mass was associated with increased feelings of inclusion, support and comfort, and fewer experiences of overt sexism. However, despite achieving critical mass at the department-level, women remained isolated within STEM subfields and male-dominated research teams. Etzkowitz and colleagues also observed a "paradox of critical mass," in which the older generation of female faculty conformed and subscribed to the "male model of doing science", while a younger generation of both male and female faculty sought to change the very culture of STEM. This paradox counters the myth that a critical mass of minoritized groups will join together towards the common goal of institutional transformation of spaces that seek to exclude them. Further, this finding lends insight into the different coping mechanisms minoritized groups draw on to counter negative STEM climates.

Deviating from the literature that examines how structural diversity impacts the educational trajectories of minoritized groups, Umbach and Kuh's (2006) study explored how liberal arts colleges fare in creating opportunities for students to engage in diversity-related experiences. The authors found that students attending liberal arts colleges report larger gains in understanding diversity and engaging in diversity-related activities than their peers at other colleges, despite lower levels of structural diversity at liberal arts colleges. Given these results, the authors set out to find what institutional characteristics of liberal arts colleges help explain these results. The authors used four measures of institutional diversity including an institution's 1) structural (racial) diversity, 2) climate for diversity, 3) diversity within the curriculum, and 4) a meta institutional diversity variable that includes all three institutional diversity measures to examine the relationship between diversity-related activities and student engagement, perceived campus environment, intellectual development, and social awareness. Although the structural diversity measure was negatively related to reported campus environment and satisfaction, the meta institutional diversity measure reverses this effect, which supports previous literature that found that an institution's structural diversity alone cannot yield the benefits of diversity. The authors concluded that "an institution does not have to be highly structurally diverse to foster meaningful diversity experiences" (p. 19).

The evidence in Umbach and Kuh's study certainly supports the rationale that different institutional types may have a stronger capacity to realize the added educational benefits associate with diversity, but it begs the question, "For whom?" While it might be true that the majority of students enrolled at liberal arts colleges (i.e. White students) do not require a diverse structural environment to reap the educational benefits associated with diversity, it us unknown if the liberal arts college "effect" holds for racial and ethnic minorities enrolled at these very institutions. Given the abundant research on how campus racial climates can vary based on a student's social position within the institution, many of which the authors cite, it is highly unlikely.

A study of Los Angeles community colleges sought to understand the association between a *critical mass* of Latino students at the campus level and Latino student success, expressed as a composite variable comprising a ratio of course success, cumulative GPA, and math and English completion (Hagedorn, Chi and Cepeda, 2007). Correlations showed that Latina/o student representation was positively associated with increased academic success, including higher GPAs and higher rates of enrollment in transfer level courses. Actual transfer, or intention to transfer, was not accounted for in this study. Results from an ordinal regression also supported the positive and modest association between increased Latino representation and student success. Similar findings emerged when the independent variable of interest was substituted for a *critical mass* variable of Latino faculty. The authors suggested that the modest "effect" of critical mass was expected, given that it is only one, albeit important, factor that impacts student success. Another limitation to this study is that it fails to account for how previous pre-college racial segregation may impact students' responses to the structural diversity they encounter at the university.

Drawing from two nationally representative samples, the National Education Longitudinal Study: 88 and the National Longitudinal Study of Freshmen: 99, Griffith (2010) examined the role between institutional characteristics, including structural diversity, and student persistence in STEM. By running separate binary logistic regressions for gender and race, Griffith found that undergraduate racial and gender composition variables, measured as the average percent of STEM undergraduate racial minority students within the first two years of college, normalized by the percent of minority students across all majors and the average percent of STEM undergraduate female students within the first two years of college, normalized by the percent of female students across all majors, are not significant predictor of student persistence. Female and racial minority measures of graduate composition in STEM, however, are positively and significantly related to undergraduate female and racial minority undergraduate persistence to degree.

Despite these important findings, there are several limitations to this study that I seek to address in this dissertation. First, in Griffith's study, minority students were combined into one category, which assumes a monolithic experience for all groups. Second, the author failed to disaggregate STEM into subfields despite the diversity of fields represented in STEM and the differences in racial minority representation across these fields. Finally, Griffith overlooked the important role upper-level classmen in STEM may play for REMs.

A different approach to the tradition of campus-level studies that view peer groups as encompassing the entire student body is Antonio's (2004) study of peer groups within a single institution. He argues that peer groups more accurately depict the college student experience by focusing on a student's proximal environment. The racial diversity of students' best friends on campus was the variable of interest. The racial composition of best friends was rated on a four-point scale on which peer groups were grouped as "homogenous," "predominantly one race," "majority one race," and "no majority." The primary method of analysis was blocked multiple regression, which captures precollege factor experiences, a measure of diversity within friendship groups, and student involvement for white students and students of color. Results from the study suggest that racially diverse peer groups are associated with enhanced self-confidence and educational aspirations for students of color, and lower self-confidence and educational aspirations for White students. Antonio also found that peer groups may play a larger role than he initially expected, because peer groups isolate students from institutional influences.

Summary

The review of the literature finds that REM retention in STEM degrees is related to precollege factors, student's educational backgrounds, and the institutional context. In particular, the racial climate is unique variable in the REM departure puzzle. The campus racial climate of an institution impacted by external factors such as the political and sociohistorical context, as well as the various factors that make up the institutional context: legacy of exclusion, psychosocial, behavioral, and structural factors. This review of the literature supports the important role that structural diversity plays in a variety of educational outcomes for minoritized groups on the overall campus and particularly in STEM.

Chapter 3

Study One

Research Question

How do the movement patterns between college majors of Latina/o students compare to those of their Asian, Black, and White peers?

a. How do movement patterns for STEM students differ at the intersections of Latino ethnicity and gender?
b. How do movement patterns for STEM students differ at the intersections of Latino ethnicity and socioeconomic status?

Data

This study is informed by semester-to-semester institutional data on students enrolled at six large, public, predominantly white, selective research institutions located in the Midwest and Mid-Atlantic regions beginning in the Fall of 1999 through Spring YEAR (N=41,893). These data were gathered as part of the Andrew W. Mellon Foundation's Public University Database Project. In this database, the Fall 1999 cohort is tracked over a period of six academic years or until a student exits the university (i.e., graduates, transfers out, drops out, or stops out).

Institutional data were made available for all students who enrolled at these six institutions beginning in Fall 1999, which allows for a detailed analysis of the patterns of movement in and out of majors for non-STEM and STEM students, as well as out of and into STEM for each racial group. This is important because there is a limited literature base that highlights the Latino experience in STEM, despite evidence citing the unique educational obstacles that may limit Latino participation in postsecondary education (Contreras, 2005). Additionally, these data allow us to measure persistence in STEM to degree completion without the use of proxies, such as the number of upper-level STEM courses completed (Maltese & Tai, 2011), persistence in science and engineering career aspirations (Mau, 2003), and following through on intentions to major in STEM at the end of first year (Chang et al., 2011).

The data for this study were restricted in a few important ways. First, the sample was limited to include first-time, full-time, domestic students with institutional records that provide information about race/ethnicity and gender. At the intersection of Latino ethnicity and socioeconomic status, and to answer the second sub-question of this study, I limit the observations to Latino FAFSA filers who began in a STEM field in Fall 1999 (N=317). Pell Grant eligibility during the first year of enrollment is used as a proxy for determining students' socioeconomic status; thus Latino STEM students who failed to file a FAFSA were excluded from this portion of the study because information about Pell Grant eligibility was unknown.

Data Analysis

To answer the primary research question, I use cross-tabulation analysis to capture if a student changed their major by looking at the student's declared major in their first semester and their major in their final semester of enrollment before they graduated, as well as if the student had persisted to degree at the campus-level. In line with previous work on STEM participation rates, and as outlined in the National Science Foundation's SESTAT[2] tool for studying Scientists and Engineers, a broad definition of STEM is used to capture minority participation in math and science-based fields beyond the traditional "high-status" disciplines of engineering and computer science (George-Jackson, 2011; National Science Foundation, 1999). The five STEM fields identified by the SESTAT tool include computer and mathematical sciences, life sciences, physical sciences, social sciences and engineering, and they are cross-referenced with the two-

[2] Health sciences and STEM secondary teachers are excluded from NSF's definition of STEM

digit Classification of Instructional Programs (CIP) code for each STEM subfield (see Appendix A). When the two-digit CIP code failed to correctly classify a program as STEM or non-STEM based on NSF's definition, the six-digit code was used (e.g. public policy). Given that most STEM students who exit the university do so within the first two years of college (Griffith, 2010), students who were still enrolled after six years are considered persisters in this study. Undeclared first-year students were classified as non-STEM majors.

Cross-tabulation is appropriate for the analysis of categorical data, such as those presented in this study. This approach records the frequency of respondents who fall under certain categories, in this case the joint distribution of students who belong to one of the five racial categories of interest and the number of students who remain in their initial area of study, move out of their initial area of study and into a non-STEM or another STEM field of study, or depart the university altogether. The observed values are then compared to the expected values to assess whether a relationship exists between the two variables of interest using a Pearson Chi-square statistic (Field, 2013). A limitation to this test is that it does not provide information about which subgroup is statistically different from another, but rather it captures whether there is an overall difference in the frequency distribution across groups.

To address the two sub-questions, I employ cross-tabulation analysis and a Pearson Chi Square test statistic to examine movement patterns at the intersection of gender and Latino ethnicity, as well as at the intersection of Latino ethnicity and socioeconomic status. Due to the small sample size, I examine gender and socioeconomic differences for Latinos who began in a STEM field for the following outcomes: students received any STEM degree, students received a non-STEM degree, and students left the university altogether. At the intersection of Latino ethnicity and gender, differences between male and female Latino students are of interest. At the intersection of Latino ethnicity and socioeconomic status, Pell status serves as a proxy for socioeconomic status, and differences between Latino Pell recipients and non-recipients are of interest.

Demographic Information

Table 12 summarizes the demographic characteristics of students in the study. The student sample across all six institutions was evenly distributed between male and female students, and this distribution holds when the sample is restricted to Latino students. An overwhelming majority of the total student sample reported their race/ethnicity to be White (80.9%). The second largest racial/ethnic category was Asian (8%), followed by Black (6%), Latino (3%) and Other (2%). The majority of students graduated with a degree by Fall 2005 (74.4%), with about 1 in 4 students exiting the university before receiving a degree. Close to 90% of all Latino students filed a Free Application for Federal Student Aid (FAFSA) application, higher than the number of FAFSA filers in the complete sample (74.5%). This number holds when data is restricted to Latino STEM students. About half of Latino STEM FAFSA filers came from households where at least one parent had a bachelor's degree or above and from households with incomes above $50,000. While these numbers are well above the average educational attainment and household income of Latinos in these states, they reflect the backgrounds of students attending large, public, research universities (Astin & Oseguera, 2004). STEM fields of study with the largest number of non-FAFSA filers in the first year included the social sciences (19.7%), engineering (11.9%), and life and related sciences (9.6%).

Table 12
Demographic Information, Fall 1999

	n	%
Gender		
Male	18,108	49.8
Female	18,195	50.1
Race and Ethnicity		
Asian	2,849	7.8
Black	2,130	5.9
Latino	1,183	3.3
Other	778	2.1
White	29,363	80.9
Graduation Status		
Graduated	27,018	74.4
Still enrolled (fall 2005)	578	1.6
Did not graduate, no longer enrolled	8,707	24.0
Latinos in STEM	360	30.4
FAFSA filers	317	88.1
Pell recipients	106	29.4
Parental Education- Latino STEM FAFSA Filers		
Less than high school	24	7.6
High school diploma	82	25.9
College or beyond	164	51.7
Other/unknown	30	9.5
Missing	17	5.4
Parental Income- Latino STEM FAFSA Filers		
Less than 25,000	57	18.0
25,000-49,999	77	24.3
50,000-74,999	63	19.9
75,000-99,999	42	13.2
100,000-124,999	19	6.0
More than 150,000	24	7.6
Missing	35	11.0

Note: 10% of missing data for parental income can be attributed to one institution that was systematically missing parental income information.
Source: Author’s Calculations

First-year Field of Study

The majority of students in the Fall 1999 cohort began their undergraduate careers as non-STEM majors, and this holds across all racial groups (see Table 13). Asian students declared non-STEM majors at the lowest rate and Black students declared non-STEM majors at the highest rate. Consistently, Black and Latino students entered STEM fields at lower rates than their White and Asian peers, except for the social sciences. The Pearson Chi-Square test statistic indicates that there are statistically significant racial differences in the selection of first semester major for the Fall 1999 cohort, χ^2 (20, N = 36,303) = 244.01, p = .00. In engineering, Asian students entered the field at double the rates of their Black peers. Similarly, White students entered the physical sciences at almost double the rates of their Black and Latino peers. Overall, however, few students declared a physical science major their first year. Latino students who pursued STEM degrees entered engineering fields at the highest rates (14.2%), followed by life and related sciences (7.0%).

Table 13
Declared Major Group by Race, Fall 1999

	Non-STEM		*Life & related sciences*		*Computer & mathematical sciences*		*Engineering*		*Physical sciences*		*Social sciences*	
	N	%	N	%	N	%	N	%	N	%	N	%
Asian	1,754	61.6	210	7.4	129	4.5	613	21.5	43	1.5	100	3.5
Black	1,640	77.0	118	5.5	55	2.6	227	10.7	19	0.9	71	3.3
Latino	823	69.6	83	7.0	34	2.9	168	14.2	9	0.8	66	5.6
Other	510	65.6	49	6.3	25	3.2	136	17.5	10	1.3	48	6.2
White	18,944	64.5	2,639	9.0	899	3.1	5,044	17.2	493	1.7	1,344	4.6

Source: Author's Calculations

Results

Student Movement Out of Non-STEM Majors

Latino persisters who began their undergraduate degrees in non-STEM fields graduated in a non-STEM field at a rate of 65% (see Table 14). This group of majors has one of the highest rates of persistence at the campus-level for Latino students (70.1%), second only to physical science majors (77.8%). About 28% and 4%, respectively, of Latino persisters who initially declared non-STEM majors received degrees in the social and life and related sciences, accounting for 77% of social science and 38% of life and related science degrees received by Latino students. Across all racial groups, the social sciences were the most popular destination for non-STEM switchers, that is, those students who began in a non-STEM major and who changed majors prior to their final semester of enrollment prior to graduation. While all racial groups saw movement into other STEM fields, Asian students had the highest movement with approximately 1 in 5 students entering a non-social science STEM field. The Pearson Chi-square test statistic indicates that there are statistically significant racial differences in student movement patterns out of non-STEM and out of the university for non-STEM majors, χ^2 (24, N = 23,671) = 438.62, p = .00.

Table 14.
Movement of Students who Began in Non-STEM by Race

	Asian		Black		Latino		Other		White	
	N	%	N	%	N	%	N	%	N	%
Degree Received										
Non-STEM	768	55.8	701	66.1	375	65.0	211	64.7	10,445	72.3
Life and related sciences	123	8.9	41	3.9	23	4.0	16	4.9	726	5.0
Computer and mathematical Sciences	60	4.4	13	1.2	5	0.9	7	2.1	248	1.7
Engineering	45	3.3	12	1.1	10	1.7	10	3.1	282	2.0
Physical sciences	18	1.3	8	0.8	2	0.3	2	0.6	87	0.6
Social sciences	363	26.4	285	26.9	162	28.1	80	24.5	2662	18.4
Total graduated	1,377	78.5	1,060	64.6	577	70.1	326	63.9	14,450	76.3
No longer enrolled	377	21.5	580	35.4	246	29.9	184	36.1	4,494	23.7

Source: Author’s Calculations

Student Movement Out of Physical Science Majors

During the period covered by the data, two out of the three Latino students who earned a physical science degree across all six universities began their undergraduate career in a non-STEM field, while no Latino students who initially began in the physical sciences graduated with a physical science degree (see Table 15). Only 0.4% (3) of all Latino undergraduate degrees were awarded in the physical sciences. The physical sciences also had the lowest retention to degree among all racial groups, with White students persisting to degree at the highest rate (37.9%). Close to 60% of all Black and Latino students who began their undergraduate careers in the physical sciences graduated with degrees in the social sciences or non-STEM fields, while a larger proportion of White and Asian students persisted in the physical sciences or re-entered and graduated in one of the other STEM fields, χ^2 (24, N = 574) = 43.19, p = .01.

Table 15.
Movement of Students Who Began in Physical Sciences by Race

	Asian		Black		Latino		Other		White	
	N	%	N	%	N	%	N	%	N	%
Degree Received										
Non-STEM	7	18.9	0	0.0	5	71.4	3	60.0	86	22.6
Life and related sciences	4	10.8	1	8.3	0	0.0	0	0.0	27	7.1
Computer and mathematical sciences	3	8.1	0	0.0	0	0.0	0	0.0	19	5.0
Engineering	7	18.9	1	8.3	2	28.6	1	20.0	45	11.8
Physical sciences	11	29.7	3	27.3	0	0.0	1	20.0	144	37.9
Social sciences	5	13.5	7	58.3	0	0.0	0	0.0	59	15.5
Total graduated	37	86.0	12	63.2	7	77.8	5	50.0	380	77.1
No longer enrolled	6	14.0	7	36.8	2	22.2	5	50.0	113	22.9

Source: Author's Calculations

Student Movement Out of Engineering Majors

Black and Latino students who started their undergraduate careers in non-STEM degrees entered engineering fields at a rate of 2% or less, yet made up 10% and 11% of all engineering degrees received by these two groups. Approximately 11% of Latinos graduated with engineering degrees by Fall 2005. Latinos had the lowest retention rates in engineering, when compared to their peers (see Table 16), as well as the second highest departure rate from the university (32.1%). Latino students who left engineering entered non-STEM fields at the highest rates (20.2%). Latino engineering switchers also made-up 10% of all life and related sciences, and 17% of computer and mathematical sciences graduates, lower than the percentage of Asian and White engineering switchers who graduated in computer and mathematical sciences (22.4% and 30.9% respectively). The Pearson Chi-square test statistic indicates that racial differences are present in student movement out of engineering and out of the university for students who began their undergraduate degrees in engineering, χ^2 (24, N = 6,188) = 89.70, p = .00.

Table 16.
Movement of Students Who Began in Engineering by Race

	Asian		Black		Latino		Other		White	
	N	%	N	%	N	%	N	%	N	%
Degree Received										
Non-STEM	52	10.1	25	16.7	23	20.2	19	47.6	620	15.1
Life and related sciences	13	2.5	3	2.0	6	5.3	0	0.0	116	2.8
Computer and mathematical sciences	39	7.5	7	4.7	4	3.5	5	4.6	303	7.4
Engineering	379	73.3	102	68.0	73	64.0	73	67.6	2,812	68.4
Physical sciences	7	1.4	1	0.7	0	0.0	4	3.7	72	1.8
Social sciences	27	5.2	12	8.0	8	7.0	7	6.5	187	4.5
Total graduated	517	84.3	150	66.1	114	67.9	108	79.4	5,044	81.5
No longer enrolled	96	15.7	77	33.9	54	32.1	28	20.6	934	18.5

Source: Author’s Calculations

Student Movement Out of Life and Related Science Majors

Approximately 45% of Other and 42% of Black students who began their undergraduate careers in life and related sciences left their original institution of enrollment (see Table 17). The rates of retention to degree in life and related sciences for Latino is 55%, which is the highest among all racial groups. Students across all racial groups who switched from life and related science majors generally moved into non-STEM and social science majors; among Latinos, the figure was 1 in 3. The Pearson Chi-square test statistic indicates that there are racial differences in student movement out of life and related sciences and out of the university for students who began their first semester as life and related sciences students, χ^2 (24, N = 3,099) = 73.632, p = .00.

Table 17.
Movement of Students Who Began in Life and Related Sciences by Race

	Asian		Black		Latino		Other		White	
	N	%	N	%	N	%	N	%	N	%
Degree Received										
Non-STEM	47	28.5	29	42.6	9	16.1	9	33.3	600	29.5
Life and related sciences	79	47.9	24	35.3	31	55.4	10	37.0	1,111	54.7
Computer and mathematical sciences	5	3.0	3	4.4	2	3.6	1	3.7	30	1.5
Engineering	10	6.1	1	1.5	5	8.9	3	11.1	70	3.4
Physical sciences	2	1.2	0	0.0	1	1.8	1	3.7	29	1.4
Social sciences	22	13.3	11	16.2	8	14.3	3	11.1	191	9.4
Total graduated	165	78.6	68	57.6	56	67.5	27	55.1	2,347	77.0
No longer enrolled	45	21.4	50	42.4	27	32.5	22	44.9	608	23.0

Source: Author's Calculations

Student Movement Out of Computer and Mathematical Science Majors

Three percent of Latino graduates received computer and mathematical science degrees. Of these students, 21% began their undergraduate degrees in non-STEM fields. Latinos who initially declared majors in computer and mathematical sciences persisted to degree at the second highest rate when compared to their peers (see Table 18). Black students in computer and mathematical sciences had the lowest retention to degree and the highest campus-level departure rate (35.7% and 49.1% respectively). Thirty-nine percent of Black computer science degree earners, however, began their undergraduate careers in non-STEM fields. The Pearson Chi-square test statistic indicates that there are statistically significant racial differences in student movement out of computer and mathematical sciences and out of the university for students who began their undergraduate degrees as computer and mathematical science majors, χ^2 (24, N = 1,142) = 41.44, p = .02.

Table 18.
Movement of Students Who Began in Computer and Mathematical Sciences by Race

	Asian		Black		Latino		Other		White	
	N	%	N	%	N	%	N	%	N	%
Degree Received										
Non-STEM	15	14.9	12	42.9	5	22.7	5	35.7	172	26.0
Life and related sciences	2	2.0	0	0.0	0	0.0	0	0.0	11	1.7
Computer and mathematical sciences	66	65.3	10	35.7	13	59.1	8	57.1	377	56.9
Engineering	11	10.9	2	7.1	1	4.5	0	0.0	38	5.7
Physical sciences	0	0.0	0	0.0	0	0.0	0	0.0	3	0.5
Social sciences	7	6.9	4	14.3	3	13.6	0	0.0	61	9.2
Total graduated	101	78.3	28	50.9	22	64.7	13	52.0	826	73.6
No longer enrolled	28	21.7	27	49.1	12	35.3	12	48.0	237	26.4

Source: Author's Calculations

Student Movement Out of Social Science Majors

While 1 in 4 Latinos graduated with a social science degree, only 14% of these graduates initially began as social science majors. Latino students in the social sciences persist to degree at a rate of 76.3% and depart the university at a rate of 42.4%, the highest rate of retention to degree for Latinos and the highest campus-level departure across all fields of study. Although Asian students had the lowest rate of university departure, in comparison to other racial groups, those in the social sciences experienced the most campus-level attrition. Latino and Black students who initially declared a social science major upon entering the university are the only students who experienced no movement into other STEM fields; other racial groups experienced minimal movement into STEM from the social sciences (see Table 19). The Pearson Chi-square test statistic indicates that racial differences were not observed in student movement out of the social sciences and out of the university, χ^2 (24, N = 1,629) = 32.17, p = .12.

Table 19.
Movement of Students Who Began in Social Sciences by Race

	Asian		Black		Latino		Other		White	
	N	%	N	%	N	%	N	%	N	%
Degree Received										
Non-STEM	24	32.0	12	28.6	9	23.7	11	33.3	346	34.4
Life and related sciences	1	1.3	0	0.0	0	0.0	1	3.0	24	2.4
Computer and mathematical sciences	1	1.3	0	0.0	0	0.0	0	0.0	2	0.2
Engineering	0	0.0	0	0.0	0	0.0	0	0.0	6	0.6
Physical sciences	0	0.0	0	0.0	0	0.0	1	3.0	5	0.5
Social sciences	49	65.3	30	71.4	29	76.3	20	60.6	622	61.9
Total graduated	75	75.0	42	60.0	38	57.6	33	68.7	1,005	74.3
No longer enrolled	25	25.0	29	40.8	28	42.4	15	31.3	339	25.2

Source: Author's Calculations

Gender Differences in Latino Student Movement Out of STEM Majors

At the intersection of Latino ethnicity and gender, there were clear divisions between fields of study along gender lines. A larger proportion of Latinas began their undergraduate careers majoring in life and related sciences and the social sciences, while a larger proportion of Latinos began their studies in computer and mathematical sciences and engineering. Latino males were twice as likely to declare a physical science major, 3.1 times more likely to declare a major in engineering, and 4.7 times more likely to declare a major in computer and mathematical sciences when compared to Latinas. The gender gap in these fields narrows or reverses when examining differences among degree earners: Latino males were 2.6 times more likely to receive degrees in engineering and 3.0 times more likely to earn degrees in computer and mathematical sciences, while Latinas earned 2 of the 3 physical science degrees.

Despite gender differences in declaring a STEM major, the Pearson Chi Square test detected no statistically significant gender differences in student movement out of life and related sciences, χ^2 (2, N = 83) = 1.75, p = .42. In the social sciences, gender differences are present in student movement out of STEM, χ^2 (2, N = 66) = 6.35, p = 0.04. In particular, a larger share of Latinos departed the university when compared to Latinas (64.3% and 36.5% respectively). Across all three majors where men outnumber women, women had higher campus-level graduation rates. Only within engineering, however, did Latinas have higher rates of retention in STEM when compared to Latinos (63.4% compared to 51.2%), with women persisting to degree in Engineering at higher rates than men. Overall, for Latino students who switched majors, re-entering STEM fields was often limited to entering the social sciences. The few students who switched their initial majors and re-entered STEM via non-social science STEM fields were male. The Pearson Chi Square test indicates that there were no observed statistical gender differences in movement out of STEM or the university for initial majors in computer and mathematical sciences, χ^2 (2, N = 34) = 0.027, p = .987; engineering, χ^2 (2, N = 168) = 2.64, p = .27; or physical sciences, χ^2 (2, N = 9) = 3.6, p = .17.

Differences in Latino Student Movement Out of STEM Majors by Pell Grant Status

Latino Pell recipients entered and graduated in STEM fields at rates similar to those of their Latino peers who were not eligible for Pell. In all but life and related sciences and the social sciences, Latino Pell recipients departed the university at higher rates when compared to their non-Pell-eligible peers. When examining differences in retention to degree in STEM fields, Latino Pell recipients had lower rates of persistence across all STEM fields of study when compared to their non-Pell-eligible peers (see Table 20). These differences, however, were not statistically significant in the life and related sciences, χ^2 (2, N = 75) = 1.13, p = 0.57; life computer and mathematical sciences, χ^2 (2, N = 32) = 1.97, p = .37; engineering, χ^2 (2, N = 148) = 1.17, p = .56; or the physical sciences, χ^2 (2, N = 9) = 1.35, p = .51. In the social sciences, a 18% difference in campus level persistence in favor of non-Pell-eligible Latinos is observed, while differences in movement patterns out of STEM for students who began their degrees in the social sciences were not statistically significant, χ^2 (2, N = 53) = 3.45, p = .18.

Table 20.
Movement of Latino STEM Students by Gender and Income

	Female		Male		Pell		Non-Pell	
Field	N	%	N	%	N	%	N	%
Life and related sciences								
Persisted in any STEM field	30	62.5	17	48.6	14	56.0	30	60.0
Persisted in non-STEM field	4	8.3	5	14.3	4	16.0	4	8.0
No longer enrolled	14	29.2	13	37.1	7	28.0	16	32.0
Social sciences								
Persisted in any STEM field	27	51.9	2	14.3	9	42.9	14	43.8
Persisted in non-STEM field	6	11.5	3	21.4	1	4.8	7	21.9
No longer enrolled	19	36.5	9	64.3	11	34.4	11	52.4
Computer and mathematical sciences								
Persisted in Any STEM Field	1	16.7	4	14.3	2	28.6	14	56.0
Persisted in Non-STEM Field	3	50.0	14	50.0	2	28.6	3	12.0
No longer enrolled	2	33.3	10	35.7	3	42.9	8	32.0
Engineering								
Persisted in any STEM field	6	14.6	17	13.4	24	48.0	56	57.1
Persisted in non-STEM field	26	63.4	65	51.2	8	36.0	14	14.3
No longer enrolled	9	22.0	45	35.4	18	36.0	28	28.6
Physical Sciences								
Persisted in any STEM field	0	0.0	2	33.3	0	0.0	2	33.3
Persisted in non-STEM field	3	100.0	2	33.3	2	66.7	3	50.0
No longer enrolled	0	0.0	2	33.3	1	33.3	1	16.7

Source: Author's Calculations

Discussion

While this study examines racial differences in student departure from STEM majors, the main contribution of this chapter is its focus on within group differences at the intersections of gender and socioeconomic status for Latino students, a population that is grossly understudied in STEM. This study follows a growing body of literature that simultaneously examines underrepresentation by race and other salient social identities (George-Jackson, 2011; Ong, Wright, Espinosa, & Orfield, 2011; Riegel-Crumb & King, 2010). Results point to the need to disaggregate for within group differences in future research, as well as the need for interventions that target issues that arise at the intersections of these important social identities.

While previous literature indicates that very few students of color enter and receive STEM degrees after leaving non-STEM fields (Bonous-Hammarth, 2000), results from this study suggest that Latino and Black students are switching into STEM fields at a considerable rate. Given the small number of students of color who declare STEM degrees to begin with, this is especially evident in the number of students who are switching from non-STEM fields to social and life and related sciences. This result warrants further research and presents another avenue for increasing the number of under-represented students in STEM by recruiting students at the undergraduate level. This opportunity can be facilitated through the creation of interdisciplinary STEM courses that can introduce students to STEM fields and careers. Information-focused interventions at the college level should not seek to replace early information interventions that seek to increase STEM aspirations for traditionally underrepresented groups.

Despite promising findings from the Higher Education Research Institute that depict how racial and ethnic minorities aspire to STEM at similar rates as their White peers (Herrera & Hurtado, 2011), findings from this study indicate that aspirations may not translate into actual enrollment for students of color. Consistently, Black and Latino students in this study enter STEM at lower rates than their White and Asian peers, except in the social sciences. Riegel-Crumb and King (2010) suggest that differences in choice of major by race can be attributed to racial inequalities in pre-college preparation, as admissions into undergraduate STEM majors are contingent on previous STEM preparation (i.e. courses taking and grades).

In addition to inequitable access, students of color who entered college as STEM majors also have higher campus-level attrition rates as compared to their non-STEM peers, contradicting previous claims that students of color who begin in STEM have higher campus-level completion rates when compared to their non-STEM counterparts (Fenske et al., 2000). While some of these differences may be attributed to variations among the institutions represented in this sample, the ability to account for differences within STEM subfields provides some unique insight into factors that contribute to different types of attrition (i.e. campus or STEM). For example, the social sciences produce the highest retention rates at degree for Latinos and also contribute to the largest amount of campus-level attrition, while the physical sciences lose the most students but account for the least attrition at the campus-level.

Results from this study also depict large gender differences among Latinos in STEM. Reflecting national trends (NSF, 2014), Latino males in this study were two times more likely to declare a major in the physical sciences, three times more likely to major in engineering, and five times more likely to major in computer and mathematical sciences. Given that no gender differences in favor of men were found in student movement out of STEM, and that Latinas enroll at four-year institutions at higher rates than Latinos (Riegel-Crumb & King, 2010), an increase in the number of Latinas choosing to enter traditional STEM fields of study can have significant implications for reducing the gender gap in STEM degree production. Consistent with recent findings from Camacho and Lord's (2013) study on Latinas in engineering, this study finds that the point of intervention for increasing Latina participation in engineering, as well as other STEM fields of study, is at the recruitment stage, as opposed to retention-based interventions. Seymour and Hewitt's (1997) seminal study of under-represented groups in STEM also supports that most gender differences are found in students' decisions to enter STEM, where women often cite the role of significant adults in their initial decisions to pursue STEM degrees. Similarly, literature focusing on successful Mexican American women in STEM points to the important role that teachers and family members play in students' postsecondary decisions (Cantú, 2011). Self-confidence is cited as playing a major role in Latino students' decisions to enter STEM, with the largest negative effect being on Latina women (Leslie, McClure, & Oaxaca, 1998). As such, interventions aimed at Latinas should seek to include parents, teachers, and other positive adult role models.

Latinos in this study may be experiencing some unique challenges. While gender differences in persistence at the campus-level were only found to be statistically significant in the social sciences, the data depict a large share of Latino men who exit the university altogether when leaving STEM. Some explanations for this may be related to the differential impact of the weed-out system on men, where men are less likely to seek out supportive peer groups or help (Seymour, 1997). Failure to seek support in an often unwelcoming STEM environment may disproportionately affect Latino males, a group that has been associated with coping with academic hardships through self-reliance (Gloria, Castellanos, Scull & Villegas 2009).

Finally, while there is very little consensus on the relationship between students' socioeconomic status and pursuing and persisting in STEM fields (Engberg & Wolniak, 2013; Maltese & Tai, 2011; Leslie et. al., 1998; Staniec, 2004; Trusty, 2002), findings from this study align with research that argues that socioeconomic status is not related to pursuing or earning a STEM degree (Engberg & Wolniak, 2013; Maltese & Tai, 2011). Lower income Latino students appear to be leaving the university at higher rates, but no statistical differences in access to or departure from STEM or the university were found between Pell-eligible Latino STEM students and their non-eligible peers. It is possible that the imperfect measure of socioeconomic status may obscure advantages that accrued to students with parents who are college educated or work in STEM occupations (Cantú, 2011; Leslie et al., 1998). Future research should aim to capture the impact of fluctuations in net price and financial aid for Latino students over time given their aversion to debt (Munoz & Rincón, 2015). The increasingly popular adoption of tuition differential policies in STEM fields at large, public research universities also pose a threat to increasing underrepresented student access and retention in STEM degrees (George-Jackson).

Limitations

The results from this study should be interpreted with a few limitations in mind. First, terms matter (George-Jackson, 2009). It is very possible that a different definition of STEM would have produced completely different results, however, but the decision to include the NSF's definition of STEM was purposeful, given NSF's funding priorities, which exclude health sciences, engineering technologies, and STEM secondary teachers.

Second, this study does not account for how differences in pre-college preparation impact students' decisions to enter, persist or leave STEM. Pre-college educational inequalities disproportionately impact lower income, first generation, and racial and ethnic minorities who often do not have access to resources needed to make a difference in access and persistence in STEM, in particular rigorous math and science preparation, qualified teachers, adequate career counseling.

Third, the results from this study have limited generalizability both in terms of the institutions represented in the study (i.e. institution type, size, and selectivity), the students who enroll at these institutions, and the geographical and regional contexts of these institutions. It is especially important to note the selection bias at selective public universities, which influences the process by which students choose colleges and colleges choose students (i.e. these choices are not random) (Bowen and Bok, 1998). As such, the generalizability of these findings should be limited to these particular contexts and should not be applied to all students in all higher education settings. The replication of this study in different contexts is needed to confirm its generalizability across populations and contexts.

Fourth, because data limitations do not allow for disaggregation within racial/ethnic groups, thus Latino populations were treated as a homogenous group. As such, very important educational subgroup differences among Mexican, Puerto Rican, Cuban, Central and South American groups were not captured. Future data collection strategies should attempt to allow for disaggregation across sub-groups. For example, educational attainment data for Central (44.1%) and Mexican American (40.1%) groups reveal that they are, respectively, almost two and three times as likely to hold less than a high school diploma when compared to Puerto Ricans (22.6%), Cubans (20.1%) and South Americans (15%) respectively (U.S. Census, 2010). Disaggregating within groups across all racial categories will allow for targeted STEM interventions that yield a larger number of STEM. For example, pre-college STEM interventions may target Mexican and Central American communities in order to increase high school completions, college readiness, and preparation to enter STEM degrees. These pre-college interventions may include a specific curriculum aimed at first generation college students (e.g. college trips, college requirements, financial aid workshops, parent workshops, mentoring programs).

The data are also limited by their ability to capture students' intentions to enter STEM at the undergraduate level. For example, some students may choose to enroll in non-STEM fields to increase their chances of gaining acceptance to the university or to circumvent tuition differentials in STEM fields, that is, charging students higher tuition for specific majors and courses that are costlier to deliver (George-Jackson, Rincón, & Martinez, 2012). Finally, it is unknown where students go after exiting the university. Do students continue pursuing STEM at other institutions? Do they stop-out and re-enroll at a later date, and if so, what major do they pursue at the time of re-enrollment?

Conclusion

In conclusion, findings from this study present an opportunity for academics, practitioners and policy makers alike to be less reactive to changes in student demographics and to prepare for a growing number of Latino students at the postsecondary level, especially in non-traditional Latino destinations, such as those included in this study. One of the major findings from this study suggests that Latino entrance and persistence in STEM fields varies by subfield. However, Latino students consistently have lower rates of entrance and persistence in high status STEM fields when compared to their White and Asian peers. Given the number of Black and Latino non-STEM degree aspirants switching into STEM fields, results also indicate that there is an opportunity to recruit STEM students in college. This study also confirms large gender disparity among Latino STEM matriculants, however, there are no statistical gender differences in persistence to degree. In fact, the Latino STEM gender gap narrows or reverses when examining degree attainment. Finally, this study does not find any statistical differences in STEM entrance or persistence by Pell eligibility. While findings from this study risks stereotyping students of color and women as being less interested in STEM fields or less likely to succeed once enrolled, it is important to understand student trajectories in order to inform efforts to promote student success despite the many obstacles Latinos encounter.

Chapter 4

Study Two

Research Question

Does the racial and ethnic composition of STEM subfields (i.e. computer and mathematical sciences, life sciences, physical sciences, social sciences and engineering) impact the probability of Latino student departure from STEM?

a. How, if at all, does the relationship between racial and ethnic composition and STEM departure differ for Black, Latino and White students?
b. How do the various levels of structural diversity, as measured by racial composition, impact Latino students' retention in STEM subfields (e.g. cohort-level, upper-division, and graduate-level)?

Data

This study is informed by semester-to-semester institutional data on students enrolled at six, large, public, predominantly White, selective research universities located in the Midwest and Mid-Atlantic regions beginning in the Fall of 1999 (N=41,893). These data were gathered as part of the Andrew W. Mellon Foundation's Public University Database Project (PUDP). In this database, the Fall 1999 cohort was tracked over a period of six academic years or until a student exited the university (i.e., graduated, transferred out, dropped out, or stopped out), which allows for a detailed analysis of STEM student movement patterns out of STEM and out of the university for each racial group (George-Jackson, 2011). Additionally, these data permit the measurement of persistence in STEM to degree completion without the use of proxies (Chang et al., 2011; Griffith, 2010; Maltese & Tai, 2011; Mau, 2003).

For the purpose of this study, the data are restricted in a few important ways. First, the sample is restricted to first-time, full-time domestic Black, White, and Latino students who declared a STEM degree in Fall 1999. While Latino STEM persistence to degree is of primary interest in this study, it is helpful to contextualize the Latino experience alongside that of White students, a racial majority in STEM, and of Black students, another underrepresented racial minority group in STEM. Cases without information about students' gender are also excluded from data analysis. The final data set included a sample of 414 Black students, 326 Latino students, and 9,731 White students across six institutions.

In addition to institutional student-level data, this study also uses data from the Integrated Postsecondary Education Data System (IPEDS) to capture institutional characteristics from the six institutions included in this study. Using IPEDS data, two of this study's three primary independent variables of interest were created: upper-division and graduate-level racial composition.

The conceptual model of this study (see Figure 1) is informed by Hurtado, Milem, Clayton-Pedersen, and Allen's (1998) campus racial climate framework. This conceptual model depicts the ways that students respond to structural diversity, where structural diversity is described as the *first step* that must be taken to foster a positive climate on campus. Given that the four institutional factors outlined in the framework—historical legacy of exclusion, structural diversity, psychological climate and behavioral dimension—are interconnected, the presence of a large number of students of color on campus has the *potential* to influence both peer and faculty cross-racial interactions (i.e. behavioral dimension), as well as perceptions of intergroup relations (i.e. psychological climate). Despite their importance, data constraints limit the ability to account for the behavioral and psychological dimensions of this conceptual framework.

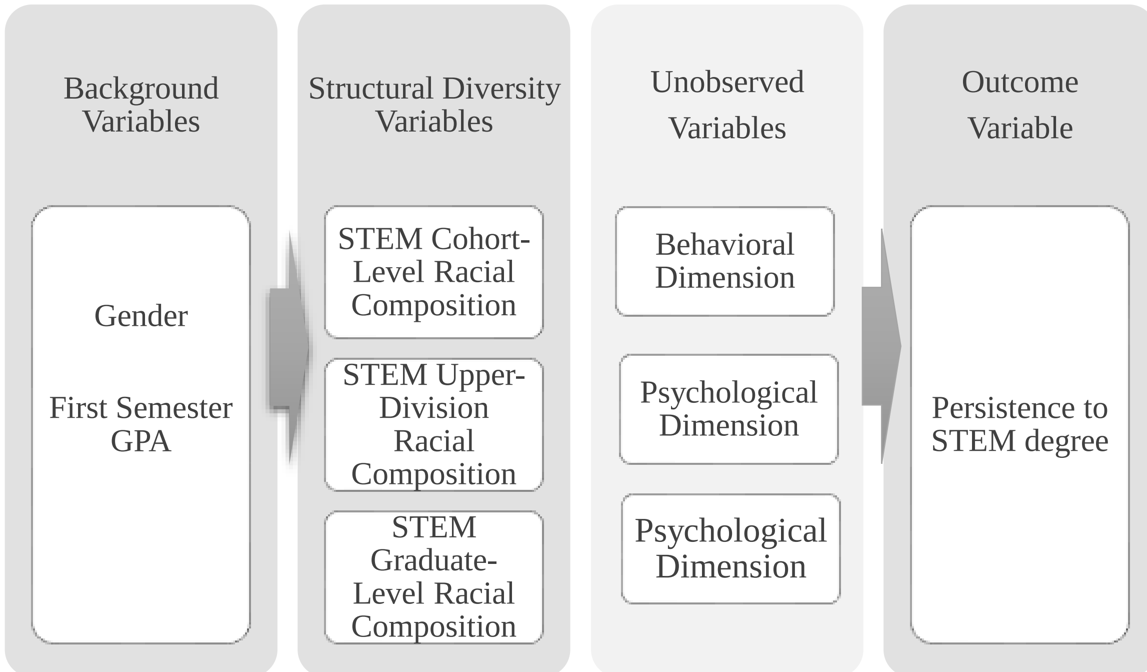

Figure 2. Conceptual Model.

First Level: Background Variables

The first level of Figure 1 captures students' background variables, including gender and academic preparation. Background variables are important to consider because they shape how students respond to the institutional context. Social identities, and the intersections of these identities, are important determinants of entrance and persistence in STEM (Bonous-Hammarth, 2000; Rincón, 2015). In particular, Latino students have one of the largest gender gaps in STEM participation (NSF, 2014). Pre-college academic preparation is also a strong predictor of STEM success (Bonous-Hammarth, 2000; Chang et al., 2010; Crisp, Nora, Taggart, 2009; Elliott et al., 1996; Griffith, 2010; Herrera & Hurtado, 2011; Palmer, Maramba, & Dancy, 2011; Staniec, 2004). Academic preparation, measured by first semester GPA, serves to gauge a student's ability to do college-level coursework. While this measure is imperfect, previous research by Crisp and colleagues (2009) find that first-semester GPA is associated with STEM degree completion across all racial groups.

Second Level: Institutional Context

The racial composition variables in the second level of the conceptual model measures one aspect of the institutional context that is of interest to this study: structural diversity. Structural diversity, or racial composition, is measured at three distinct levels, including the 1) cohort-level, 2) upper-division level, and 3) graduate-level. An upper-division racial composition variable serves as a proxy for same-race near-peer mentors, an important form of academic and social support for students of color in STEM broadly (Palmer et al., 2011), and Latino STEM students in particular (Cole & Espinoza, 2008; Seymour & Hewitt, 1997). In addition to measuring the role of upper-division undergraduate student status on undergraduate STEM persistence, this study also seeks to account for the presence of same-race graduate-level students on student URM student persistence. Inclusion of this variable was informed by Griffith's (2010) study that found a positive relationship between racial diversity of STEM graduate students and undergraduate persistence in STEM for students of color. As such, graduate-racial composition is measured by doctoral degree completion, as doctoral students are more likely to serve as teaching assistants than master's level students, and therefore, have more contact with undergraduate STEM majors.

The third level is informed by three unmeasurable items that make up the institutional context of the campus racial climate framework: behavioral aspect, psychological aspect, and historical legacy of inclusion or exclusion. While these constructs are not directly measurable, they are included in this figure because they are associated with the presence of structural diversity (Milem, et al., 1998).

Fourth Level: Dependent Variables

The final level contains the outcome of interest: persistence to STEM degree. A student's decision to persist to degree is modeled as three options: 1. persists in any STEM degree, 2. persists in a non-STEM degree, and 3. departs the university. To capture degree completion in any STEM field, I examine if a student's first semester major changed during their final semester of enrollment prior to graduation. A students was labeled as a STEM persister if their final major was their initial STEM major or another STEM major. A student was labeled as a non-STEM persister if their final major was classified as non-STEM. Finally, I examine if a student left the university at any time (i.e. transferred-out, pushed-out, dropped-out, stopped-out) and categorized those students as non-persisters. In line with previous work on STEM participation rates, and as outlined in the National Science Foundation's SESTAT[3] tool for studying scientists and engineers, a broad definition of STEM is used to capture minority participation in math and science-based fields beyond the traditional "high-status" disciplines of engineering and computer science (George-Jackson, 2011; NSF, 1999). The five STEM fields identified by the SESTAT tool include computer and mathematical sciences, life sciences, physical sciences, social sciences and engineering, and are cross-referenced with the two-digit Classification of Instructional Programs (CIP) code for each STEM subfield (see Appendix A). When the two-digit CIP code failed to correctly classify a program as STEM or non-STEM based on NSF's definition, the six-digit code was used (e.g. public policy). For the purpose of this study, students who are enrolled after six years are considered persisters, as most STEM students who exit the university do so within the first two years of college (Griffith, 2010). Students without a major their first year were classified as non-STEM majors.

[3] Health sciences and STEM secondary teachers are excluded from NSF's definition of STEM.

Together, these variables help explain the odds of persisting to degree in STEM for each racial group. Table 21 includes information about how the independent and dependent variables informing this study are defined and measured.

Table 21.
Variables for Multinomial Logistic Regression Models

Dependent Variables	**Definition**	**Values**	**Source**
STEM persistence	Student persistence outcome by Fall 2005	(1 = earned any degree in STEM**, 2 = earned a degree outside of STEM, 3 = departed the university)	PUDP
Independent Variables	**Definition**	**Values**	**Source**
Background Characteristics			
Male	Student is male.	(0= No, 1= Yes**)	PUDP
First semester GPA	The first semester GPA for the fall 1999 cohort was categorized into three equal groups. The first group represents below average grades, the second group represents average cohort grades, and the last group represents above average grades.	(0 = less than 2.75**, 1= greater than 2.75 and less than 3.35, 3 = greater than 3.35)	PUDP
STEM Major			
Computer and mathematical sciences	Student declared a computer and mathematical sciences major in Fall 1999	(0= No, 1= Yes)	PUDP
Life & related sciences	Student declared a life sciences major in fall 1999	(0= No, 1= Yes)	
Physical sciences	Student declared a physical sciences major in fall 1999	(0= No, 1= Yes)	
Social sciences	Student declared a social sciences major in fall 1999	(0= No, 1= Yes)	
Engineering	Student declared an engineering major in fall 1999	(0= No, 1= Yes**)	
Structural Diversity			
Cohort-level racial composition	The number of Black, Latino, or White students in each STEM subfield divided by the total number of students in each STEM subfield for the first year of enrollment at each institution.	Continuous	PUDP

Table 21.

Variables for Multinomial Logistic Regression Models (cont.)

Upper-division racial composition	The average number of Black, Latino, or White undergraduate degree completions in each STEM subfield divided by the total number of degrees conferred in each STEM subfield for the first two years of data at each institution.	Continuous	IPEDS
Graduate-level racial composition	The average number of Black, Latino, or White PhD degree recipients at the STEM subfield level divided by the total number of students at the subfield for the first two years of data at each institution.	Continuous	IPEDS

*Note:*** Indicates the reference category

Analytical Approach

To answer the research questions that drive this study, the primary method for data analysis is multinomial logistic regression. The logit model was selected because of its ability to predict nominal outcomes (in this case, whether a student persists to a STEM degree) when the number of outcomes is greater or equal to three and has no natural order (Powers & Xie, 2000). This design is an improvement over previous studies on STEM persistence to degree that focus on two possible outcomes: if a student successfully completes a STEM degree or if a student fails to complete a STEM degree. I argue that because student departure from STEM is a more complex phenomenon than what could be modeled through a binary logit model, a dependent variable that captures this complexity is a more accurate depiction of student persistence or non-persistence in STEM.

The multinomial logistic regression uses maximum likelihood estimation to compare multiple groups and is comparable to running separate binary logistic regressions for each outcome (in this case, three), where each dichotomous outcome is compared to a reference group (Long, 1997). The equation below represents a basic multinomial logit as a probability model where y_i is a polytomous dependent variable of interest for the effect of x, given outcome *m*, with persistence in any STEM degree as the reference group. In the equation below, β_m is a vector of estimated coefficients for each outcome where the referent group $\beta_1=0$. To account for within-group differences, separate models are estimated for Latino, Black, and White STEM students.

$$\Pr(y_i = m|\mathrm{x}_i) = \frac{\exp(\mathrm{x}_i\beta_m)}{1 + \sum_{j=2}^{J} \exp(\mathrm{x}_i\beta_j)} \quad \text{for } m > 1 \tag{1}$$

Model Specifications

Several steps were taken to determine whether the assumptions underlying the multinomial logistic regression specification were appropriate for this study. First, I assessed whether the sample size requirements were met by examining the case-to-variable ratio for each model with the preferred ratio of 20 cases to each variable. Next, I tested the overall relationship, or fit, of each model using the Hosmer-Lemeshow goodness-of-fit test with 10 groups (Hosmer, Lemeshow, & Sturdivant, 2013). Finally, I examined the predicted and observed counts table for large differences.

Given that the most parsimonious model was used to assess the role of racial composition on STEM persistence, all 18 final models reported in the results section of this study met the sample size requirements for a multinomial logistic regression and exceed the preferred 20 cases to 1 variable suggested by Hosmer et al. (2013).

To evaluate whether the final model of the multinomial logistic regression fits the data, I look at the model’s ability to predict the observed outcomes. The Hosmer-Lemeshow test statistic was used to determine whether the final models were an improvement over the baseline models, which only include the constant. While the Hosmer-Lemeshow test for goodness-of-fit is a common method used for assessing goodness-of-fit for logit models, recent simulations suggest that this test statistic is sensitive to the number of groups used to estimate the test statistic (Hosmer et al., 2013). As an additional check, I also examined the predicted and observed counts table.

The models used to estimate Latino STEM retention produced non-significant Hosmer-Lemeshow p-values, indicating that the model adequately fits the data. Examination of predicted and observed counts also show a strong relationship between predicted and observed counts. Non-significance was also found for models used to estimate Black STEM retention where structural diversity was measured at the cohort and upper-division level. The model for Black STEM retention using graduate-level racial composition as a measure for structural diversity and all models for White students produced statistically significant p-values, thus indicating poor fit between the final models and the data. Although the Hosmer-Lemeshow test is sensitive to large sample sizes (Hosmer et al., 2013), further inspection of the tables of predicted and observed counts for White students showed large discrepancies. Therefore, the odds ratios produced by these models are not interpreted in the results below.

Results

Demographics

Table 22 provides a demographic profile of STEM entrants by race. Descriptive statistics reveal important differences in STEM participation by gender. White students have the largest gender gap in entry to STEM in favor of males and Black students have the smallest gender gap in STEM entry. While the gender gap for Black students in this study favors females, the gender gap for Latinos favors males. Engineering accounts for the largest share of entry into STEM across all racial groups, while physical sciences account for the smallest share. Notable differences also exist between Pell eligibility and race. White students have the lowest proportion of Pell recipients, followed by Latinos, and Black students. Latino students have lower representation in STEM compared to Black and White students across all levels of structural diversity.

Table 22.
Demographic Information

	Black		Latino		White	
	N	%	*N*	%	*N*	%
Gender						
Male	192	46.4	186	57.1	6,252	64.3
Female	222	53.6	140	42.9	3,479	35.8
First-year major						
Life & related sciences	118	28.5	83	25.5	2,629	27.0
Mathematics and computer sciences	55	13.3	34	10.4	896	9.2
Physical sciences	19	4.6	9	2.8	486	5.0
Social sciences	68	16.4	66	20.3	1,338	13.8
Engineering	154	37.2	134	41.1	4,382	45.0
First Year Pell Status						
Received Pell grant	190	45.9	102	31.3	1,097	11.3
Did not receive Pell grant	224	54.1	224	68.7	8,634	88.7
Racial Composition	*M*	*% Range*	*M*	*% Range*	*M*	*% Range*
Upper-division	4.1	0-9	2.6	0-6	79.5	62-92
Graduate	2.5	0-8	1.7	0-6	47.5	19-72
Cohort	5.1	1-8	4.19	1-9	84.2	67-95

Note: Percentages are rounded and may not add to 100.
Source: Author’s calculations

Cohort-level Racial Composition.

Tables 23 and 24 contain results from 18 multinomial regressions presented as odds ratios, which represent the relative odds of an outcome occurring relative to the referent outcome, persisting in any STEM degree. An odds ratio greater than 1 is considered a positive increase in the relative odds of the comparison outcome occurring as the variable increases, whereas an odds ratio less than 1 represents a decrease in the odds of the comparison outcome occurring as the variable increases.

***Background Characteristics*.** Table 23 contains three separate multinomial logistic models that assess the relationship between cohort-level racial composition and STEM persistence to STEM degree for Black, Latino and White STEM students. The odds ratios indicate that Black and Latino males have higher likelihoods of leaving the university and leaving STEM relative to their female peers, but no statistical differences are found.

First semester GPA emerged as a statistically significant predictor of Latino STEM students' departure from university. The odds of departing the university were 9.79 times as great if a student earned a below average GPA relative to an above average GPA for their first semester, b = 2.28, Wald χ^2 (1) = 5.30, p = .001, and 2.94 times as great if a Latino STEM student received an average GPA, b = 1.08, Wald χ^2 (1) = 2.44, p = .02. Black students who received average or below average GPAs are also more likely than their high achieving peers to leave the university. This difference, however, is not statistically significant for Black students who receive average GPAs. While GPA is a significant predictor of departing the university for Black and Latino students, it is not a statistically significant predictor of Black and Latino students leaving STEM fields for Black and Latino students.

Differences in STEM departure across fields of study vary across racial groups. Entering college as a life and related sciences major and mathematics and computer science major was associated with higher levels of college departure relative to engineering across all racial groups but statistically significant differences were observed only for Black students. Latino students majoring in social sciences were 162% more likely to leave the university relative to Latinos in engineering, b = .96, Wald χ^2(1) = 2.25, p = .02. Relative to engineering majors, Latinos in life and related sciences, mathematics and computer sciences, and social sciences have slightly lower odds of leaving STEM, but these differences are not statistically significant. Black students who enter these fields have much higher odds of leaving STEM relative to their engineering peers. The difference in the odds were as high as 233% for Black math and computer science majors. All differences in STEM persistence by field of study are statistically significant for Black students, except in the social sciences. The only STEM majors in which Latino students experience greater attrition than in engineering are the physical sciences, where the odds of STEM departure are 10.17 times higher, $b = 2.32$, Wald $\chi^2(1) = 2.60$, p = .01. Odds ratios for Black students in the physical sciences could not be estimated because all movement out of the physical sciences results in students departing the university.

Structural Diversity. Cohort-level racial composition was a significant predictor of persistence for Latino students. A 1% increase in Latino racial composition at the cohort-level was associated with a 16% drop in departure from the university, $b = -.18$, Wald $\chi^2(1) = -2.25$, p = .03. A 1% increase in Latino racial composition within STEM subfields was associated with higher odds of leaving STEM, but these differences were not statistically significant. No differences in departure from STEM or departure from the university were observed for a 1% increase in Black cohort-level racial composition within STEM subfields.

Table 23.
Odds Ratios for Multinomial Logistic Regression for Cohort-Level Racial Composition

	Left University			**Left STEM**		
	Black	Latino	White	Black	Latino	White
Cohort-level racial composition	1.02	.84*	1.02***	.96	1.14	1.07***
	(.07)	(.07)	(.00)	(.08)	(.12)	(.00)
Below average GPA	5.59***	9.79***	8.95***	1.43	1.25	2.58***
	(2.15)	(4.21)	(.66)	(.60)	(.58)	(.19)
Average GPA	1.31	2.94*	2.36***	1.03	1.65	1.60***
	(.54)	(1.30)	(.18)	(.44)	(.72)	(.11)
Male	1.39	1.64	1.15*	1.24	1.29	.87**
	(.35)	(.52)	(.07)	(.38)	(.51)	(.05)
Life and Related Sciences	1.89*	1.04	1.29***	3.09**	.75	1.49***
	(.58)	(.36)	(.09)	(1.15)	(.35)	(.11)
Mathematics and Computer Sciences	2.46*	1.25	1.71***	3.33*	.88	2.22***
	(1.04)	(.58)	(.16)	(1.72)	(.53)	(.23)
Physical Sciences	.83	.83	1.12	-	10.17**	1.24*
	(.45)	(.89)	(.14)	-	(9.09)	(.17)
Social Sciences	1.38	2.62*	1.90***	1.84	.93	2.21***
	(.52)	(1.12)	(.17)	(.86)	(.54)	(.19)

Note: Standard errors are in parentheses. *p < .05, **p < .01, ***p < .001
Source: Author's calculations

Upper-division Racial Composition

***Background Characteristics*.** Table 24 includes the same covariates as the models estimated with the cohort-level racial composition variable above, except the racial composition variable is substituted by an upper-division racial composition variable. Again, results do not support statistically significant gender differences in STEM departure or departure from the university for Black and Latino students, despite higher rates of departure from the university and from STEM fields for these groups. First semester GPA continues to be a statistically significant predictor of persistence to degree only for Latinos and Black students. Statistically significant differences in university departure disappears for Latino majors in social science, and statistically significant differences in Latino STEM departure endure for physical science majors. Interestingly, the odds of leaving STEM shift for Latino students when racial composition is measured by upper-division racial composition. While not statistically significant, mathematics and computer sciences and social sciences majors experienced higher rates of departure from STEM than did Latino engineers. Previously identified differences in STEM persistence by field of study for Black students remain virtually unchanged when examining university departure. The odds of mathematics and computer science students leaving STEM decrease and become non-significant in the upper-division model.

Structural Diversity. Substituting cohort-level racial composition with an upper-division racial composition variable generated consistent results for Latinos. A 1% increase in upper-division Latino racial composition was associated with lower odds of leaving the university, but these differences were no longer statistically significant. Similarly, a 1% increase in upper-division Latino racial composition returned higher odds of STEM departure, but these differences were not statistically significant. While an increase in racial composition at the cohort-level for Black students yielded no differences in departure from the university or from STEM, a one-unit increase in upper-division racial composition for Black students increased the odds of departing from STEM by 138%, b = .32, Wald $\chi^2(1) = 3.93$, p = .001.

Table 24.
Odds Ratios for Multinomial Logistic Regression for Upper-division Racial Composition

	Left University			**Left STEM**		
	Black	Latino	White	Black	Latino	White
Upper-division racial composition	.99	.90	1.02***	1.38***	1.07	1.07***
	(.07)	(.10)	(.00)	(.11)	(.14)	(.00)
Below average GPA	5.51***	9.65***	8.95***	1.28	1.23	2.58***
	(2.10)	(4.13)	(.66)	(.55)	(.57)	(.19)
Average GPA	1.31	3.16*	2.36***	.99	1.53	1.60***
	(.54)	(1.39)	(.18)	(.43)	(.66)	(.11)
Male	1.37	1.70	1.15*	1.38	1.26	.87*
	(.34)	(.53)	(.07)	(.44)	(.49)	(.05)
Life and Related Sciences	1.87*	1.00	1.29***	3.28**	.76	1.49***
	(.57)	(.35)	(.09)	(1.26)	(.36)	(.11)
Mathematics and Computer Sciences	2.49*	.96	1.71***	2.07	1.10	2.22***
	(.98)	(.45)	(.16)	(.99)	(.63)	(.23)
Physical Sciences	.82	1.11	1.12	-	10.10**	1.24
	(.46)	(1.18)	(.14)	-	(8.98)	(.17)
Social Sciences	1.39	2.15	1.90***	.80	1.17	2.21***
	(.55)	(.90)	(.17)	(.39)	(.64)	(.19)

Note: Standard errors are in parentheses. *p < .05, **p < .01, ***p < .001
Source: Author's calculations

Graduate-level Racial Composition

Background Characteristics. Substituting cohort-level racial composition by a measure of graduate-level racial composition yielded similar results to those observed when examining upper-division racial composition (see Table 25). Once again, male students left the university and STEM at higher rates than their female counterparts. Latino students with below average or average GPAs had higher odds of leaving the university when compared to students with above average GPAs. Although lower GPAs were associated with higher rates of departing STEM for Latino students, differences in GPA did not yield statistically significant differences in STEM departure. Finally, differences in STEM persistence by major remain consistent for Latinos.

Once again, physical science majors were more likely to depart STEM than engineering majors, b = 2.23, Wald $\chi^2(1)$ = 2.50, p = .01.

Structural Diversity. The graduate-level racial composition variable produced similar results to the upper-division racial composition variable for Latino students. Once again, no statistically significant differences were observed.

Table 25.
Odds ratios for Multinomial Logistic Regression for Graduate-Level Racial Composition

	Left University			Left STEM		
	Black	Latino	White	Black	Latino	White
Graduate-level racial composition	1.07	.97	1.01***	1.62***	1.14	1.08***
	(.07)	(.11)	(.00)	(.13)	(.16)	(.00)
Below average GPA	5.33***	9.46***	9.13***	1.13	1.19	2.47***
	(2.04)	(4.06)	(.68)	(.51)	(.56)	(.18)
Average GPA	1.27	3.18**	2.39***	.89	1.49	1.53***
	(.52)	(1.40)	(.19)	(.41)	(.64)	(.11)
Male	1.44	1.75	1.15*	1.34	1.29	.96
	(.36)	(.54)	(.00)	(.44)	(.51)	(.06)
Life and Related Sciences	1.82	1.07	1.23**	2.81**	0.72	.97
	(.56)	(.37)	(.09)	(1.11)	(.34)	(.08)
Mathematics and Computer Sciences	2.48*	1.06	1.69***	2.24	1.02	2.12***
	(.96)	(.49)	(.16)	(1.12)	(.59)	(.23)
Physical Sciences	.77	1.12	1.02	-	9.32*	.71*
	(.43)	(1.18)	(.13)	-	(8.32)	(.10)
Social Sciences	1.24	1.97	1.64***	.85	1.03	.87
	(.47)	(.85)	(.16)	(.40)	(.58)	(.08)

Note: Standard errors are in parentheses. *p < .05, **p < .01, ***p < .001
Source: Author’s calculations

Discussion

Findings from this study contribute to the literature on the important role of structural diversity in student outcomes, especially the role of same-race peers for Latinos in STEM

(Seymour & Hewitt, 1997). While the effect of structural diversity on Latino departure from the university is modest, results confirm the positive relationship found between greater Latino representation and increased educational success (Hagedorn et. al., 2007). The non-significant relationship between increased Latino representation at the cohort level and Latino departure from STEM suggest that trends in Latino representation within STEM may reflect overall trends at the university. Perhaps Latinos attending institutions with greater Latino diversity are more likely to interact with non-STEM Latinos and thus apt to switch majors (Seymour & Hewitt, 1997). Like Hagedorn et al., this study did not expect to find large "effects" between structural diversity and student persistence, given that student departure is a complex process that involves accounting for factors not included in this study, including quality of interactions. Results also suggest that Latinos in STEM may be more sensitive to their proximal environment. That is, Latinos in STEM may be more responsive to changes in the racial composition within their own cohort compared to increases in diversity for upper-division peers or graduate students.

The non-significant relationship between racial composition at the cohort-level and STEM persistence for Black students is expected, given the modest differences found for Latinos. This finding is also in line with literature suggesting that Black STEM students tend to study alone or seek academic support from teaching assistants or tutors rather than peers (Treisman, 1992; Seymour, 1995; Seymour & Hewitt, 1997).

The negative relationship between structural diversity of upper-division students on Black student departure from STEM is unexpected and counterintuitive. Perhaps this relationship is evidence of a paradox of critical mass (Etzkowitz et. al., 1994). Since Black students comprise a larger share of minority representation on campus, it is possible that there is more room for within-group variation. Seymour and Hewitt's (1997) work finds evidence of segmentation along social class lines, where Black STEM students who grew up in White neighborhoods disassociate themselves from Black STEM students who grew up in urban neighborhoods. Another explanation is that this finding may be an artifact of the data. Attempting to interpret this finding is difficult and requires further research with additional measures that will help explain what might be transpiring in these data.

Because this study focuses solely on structural diversity, as measured by racial composition, students' interpretation of and their actual experiences on campus are not captured. Although necessary, structural diversity is only one of several steps needed to create a more welcoming college environment for students of color (Hurtado et al., 2008; Umbach & Kuh, 2006). Further, due to the low numbers of Black and Latino students at the campus level it is highly unlikely that a 1% increase in student racial composition would make a visible difference for students of color in STEM. Future studies should seek to examine the impact of structural diversity on institutions and STEM environments with different levels of diversity at the institutional and department level. For example, Minority Serving Institutions created with specific missions of serving historically excluded students of color (e.g. Historically Black Colleges and Universities and Tribal Colleges), as well as those developed in response to shifting demographics at PWIs (e.g. Hispanic Serving Institutions), can provide a unique context in which to study campus racial climate for REM student retention within STEM, capturing both structural diversity and legacy of exclusion within the campus racial climate framework.

Beyond the structural diversity of MSIs, scholars point to several MSI attributes that lead to student success including higher levels of faculty mentorship and accessibility (Perna et al., 2009; Eagan et al., 2011), same-race role models (Hurtado et al., 2010), and supportive environments (Perna et al., 2009), which speak to the behavioral and psychological contexts of the campus racial climate framework. Further, in a case study of Spellman College, Perna and colleagues (2009) find that potential barriers associated with STEM departure for African American students are mitigated by the institutional practices such as a cooperative peer culture facilitated by small classrooms, student-faculty interactions, and structured research opportunities on and off campus. As such, future studies on STEM students that incorporate the various dimensions of the campus racial climate, and MSIs appear to provide a prime opportunity for this area of research.

Finally, it is important to note the large impact of grades have on student persistence at the university-level. This is likely an artifact of students who are placed on probation due to low grades. Grades, however, do not make much of a difference in students' decisions to switch STEM majors. While using first semester GPA is a good measure of students' ability to do college-level courses, first-year grades are likely to be influenced by the college environment. This result suggests that the differences observed for racial composition measures provide conservative estimates of their "effects."

Limitations

When considering the results of this study, a few limitations should be kept in mind. First, by estimating probabilities, this study aims to identify potential relationships between structural diversity and STEM persistence to degree. This study does not attempt to make causal claims. Students in this study were not the subjects of an experimental design that assigned them to particular institutions or fields of study. As such, the results have limited generalizability both in terms of the institutions represented in the study, the students who enroll at these institutions, and the geographical context of these institutions. It is especially important to note the selection bias associated with the process by which students choose colleges and colleges choose students at selective public universities (i.e. this choice is not random) (Bowen and Bok, 1998). In this light, the generalizability of these findings should be limited to the particular contexts of the six universities and should not be applied to all students in all higher education settings. The replication of this study in different contexts is needed to confirm its generalizability across populations and contexts.

Third, because data limitations did not allow for disaggregation within racial/ethnic groups, Latinos were treated as a homogenous group. The pan-ethnic Latino label conceals important educational differences amongst Mexicans, Puerto Ricans, Cubans, Central and South Americans. Future data collection strategies should attempt to allow for disaggregation across sub-groups. These differences should especially be considered for educational contexts with a higher proportion of Latinos, as well as regional contexts that have more ethnic diversity. As Latinos are an ethnic group and not a racial group, differences between Afro-Latinos, mestizos, and White-identifying Latinos are likely to arise.

Fourth, the data are limited in their ability to capture where students go after exiting the university. Do students continue pursuing a STEM degree at another institution? Do they stop-out and re-enroll at a later date? And if so, what major do they pursue at the time of re-enrollment and how do the new racial and ethnic contexts influence their decisions to persist?

Finally, while the models attempt to capture the potential effect of structural diversity in STEM subfields and across the campus at these six PWIs, the secondary nature of the data limits the ability to capture students' actual experiences of campus racial climate. Future research should seek to include these important variables. Along the same lines, because the study presented in this chapter does not capture how students respond to potential negative climates on campus, and because students have various ways of coping, future research is needed to better understand the coping mechanisms for students of color in STEM. It is reasonable to assume that students who are able to seek help or create safe spaces at PWIs will persist in spite of a negative university environment.

Conclusion

This study sought to understand the relationship between structural diversity in STEM for Latino students and student departure from STEM. Findings from this study suggest that academics, STEM subfield, and structural diversity are important factors to consider when understanding REM student departure from STEM. In particular, the racial and ethnic composition of STEM fields is related to Latino student departure from the university, but not STEM. I also find differences in how students responded to structural diversity as measured at the cohort, upper-division, and graduate-level. While the effect of structural diversity at the cohort-level on Latino departure from the university is modest, results confirm the positive relationship found between greater Latino representation and increased educational success (Hagedorn, 2007). Results also suggest that Latinos in STEM may be more sensitive to their proximal environment. That is, Latinos in STEM may be more responsive to changes in the racial composition within their own cohort compared to increases in diversity for upper-division peers or graduate students. Further, the study found that the structural diversity “effect” for Latinos was not the same for their Black and White peers. This study is important for better understanding how institutions can create environments that are more conducive to REM learning and success. Findings from this study contribute to the literature on the important role of structural diversity in student outcomes, and support previous findings highlighting the important role of same-race peers for Latinos in STEM (Seymour & Hewitt, 1997).

Chapter 5

Study Three

Research Question

How do Latino student's prior socialization contexts, such as the high school racial context, moderate, if at all, the relationship between structural diversity and student persistence to degree?

Data

This study is informed by semester-to-semester institutional data on students enrolled at six large, public, predominantly White, selective research universities located in the Midwest and Mid-Atlantic regions beginning in the Fall of 1999 (N=41,893). These data were gathered as part of the Andrew W. Mellon Foundation's Public University Database Project (PUDP). In this database, the Fall 1999 cohort is tracked over a period of six academic years or until a student exits the university (i.e., graduated, transferred-out, dropped-out, or stopped-out), which allows for a detailed analysis of STEM student movement patterns. Additionally, these data allow for the measurement of persistence in STEM to degree completion without the use of proxies (Chang et al., 2011; Griffith, 2010; Maltese & Tai, 2011; Mau, 2003). For the purpose of this study, these data were restricted to first-time, full-time, domestic Latino students who declared a STEM degree in Fall 1999.

To account for the racial attributes of these universities, campus-level enrollment for Latinos in Fall 1999 were merged with the Integrated Postsecondary Education Data System (IPEDS) for each university. To capture the racial composition of students' high schools, I merged data gathered by the National Center for Educational Statistics' Common Core Data (CCD) and Private School Universe Survey (PSS). CCD and PSS data for the 1998 school year were merged in for schools with available data. Thirty Latino STEM students were homeschooled or attended international or private schools that were not available through CCD and PSS. These 30 students were excluded from further analysis. The final data set yielded a sample of 297 Latino STEM students across six institutions.

The outcome of interest was a measure of persistence to STEM degree modeled as three options: 1) Student persists in any STEM degree; 2) Student persists in a non-STEM degree; and 3) Student departs the university. To capture degree completion in any STEM degree, I examine if a student's first semester major changed by their final semester of enrollment prior to graduation. A student was categorized as a STEM persister if their final major was their initial STEM major or another STEM major. A student was categorized as a non-STEM persister if the student graduated and their final major was classified as non-STEM. Finally, I examine if a student left the university at any time (i.e. transferred-out, pushed-out, dropped-out, stopped-out) and categorized those students as non-persisters.

In line with previous work on STEM participation rates, and as outlined in the National Science Foundation's SESTAT[4] tool for studying Scientists and Engineers, a broad definition of STEM is used to capture minority participation in math and science-based fields beyond the traditional "high-status" disciplines of engineering and computer science (George-Jackson, 2011; NSF, 1999). The five STEM fields identified by the SESTAT tool include computer and mathematical sciences, life sciences, physical sciences, social sciences and engineering, and they are cross-referenced with the two-digit Classification of Instructional Programs (CIP) code for each STEM subfield (see Appendix A). When the two-digit CIP code failed to correctly classify a program as STEM or non-STEM based on NSF's definition, the six-digit code was used (e.g.

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[4] Health sciences and STEM secondary teachers are excluded from NSF's definition of STEM.

public policy). For the purpose of this study, students enrolled after six years were considered persisters and students without a major during their first year were classified as non-STEM majors.

Analytical Approach

The data were analyzed using multinomial logistic regression. The multinomial logit model was selected because of its ability to predict nominal outcomes—in this case, whether a student persists to a STEM degree—in which the number of outcomes is greater than or equal to three and has no natural order (Powers & Xie, 2000). This design is an improvement over previous studies on STEM persistence to degree that focus on two possible outcomes: if a student successfully completes a STEM degree or if a student fails to complete a STEM degree. I argue that student departure from STEM is a more complex phenomenon than what could be modeled through a binary logit model; thus, a dependent variable that captures this complexity is a more accurate depiction of student persistence or non-persistence in STEM.

The multinomial logistic regression uses maximum likelihood estimation to compare multiple groups and is comparable to running separate binary logistic regressions for each outcome, in this case three, where each dichotomous outcome is compared to a reference group (Long, 1997). The equation below represents a basic multinomial logit as a probability model where y_i is a polytomous dependent variable of interest for the effect of x, given outcome *m*, with persistence in any STEM degree as the reference group. In the equation below β_m is a vector of estimated coefficients for each outcome where the referent group β_1=0.

$$\Pr(y_i = m|\mathrm{x}_i) = \frac{\exp(\mathrm{x}_i\beta_m)}{1 + \sum_{j=2}^{J} \exp(\mathrm{x}_i\beta_j)} \quad \text{for } m > 1 \tag{1}$$

First, I present basic descriptive statistics that describe how Latino STEM majors compare to their non-STEM peers in terms of demographic characteristics such as gender and

Pell status, as well as information about college graduation rates and the types of high schools students are coming from. Second, I use multinomial logistic regression to explore the impact of prior racial socialization contexts and campus racial climate measures on student persistence to degree.

The longitudinal nature of this data makes it possible to capture pre-college segregation experiences, particularly in the high school context, that have long-lasting effects through college and beyond (Braddock, 1980; Braddock & Gonzalez, 2010; Stearns, 2010). This line of research has found strong evidence that racial segregation experiences in high school are related to later isolation in college and the workforce. To determine whether pre-college experiences of racial segregation have perpetuating effects for Latino STEM students, I include a variable that captures the amount of same-race segregation a student was exposed to in high school. These pre-college racial experiences might influence how a student responds to different levels of structural diversity on a college campus, as well as the likelihood that students will engage in cross-racial interactions (Antonio, 2004; Hernandez, 2010; Seymour & Hewitt, 1997). That is, a student may respond differently to a campus racial context that is 5% Latino in comparison to a campus that enrolls 20% Latinos.

Different campus racial contexts, such as those produced at the departmental and college levels, are likely to produce different student responses. To account for variables that capture the structural diversity dimension of the campus racial climate, I tested the cohort-level diversity measure that represents a proxy for the racial climate students experience within STEM subfields (see Table 26). I also include a measure of overall Latino racial composition at the university level to assess whether increased diversity at the STEM cohort-level reflects campus diversity.

Finally, to account for possible confounding variables I include variables capturing students' gender, first year major, and academic preparation.

Table 26.
Table of Variables Included in Multinomial Logistic Regression Models

Dependent Variable	**Definition**	**Values**	**Source**
STEM Persistence	Student persistence outcome by Fall 2005	(1 = student earned any degree in STEM**, 2 = student earned a degree in Non-STEM, 3 = student departed the university)	PUDP
Independent Variables	**Definition**	**Values**	**Source**
Background Variables			
Male	Student is male	(0= No, 1= Yes)	PUDP
First semester GPA	The first semester GPA for the fall 1999 cohort was categorized into three equal groups. The first group represents below average grades, the second group represents average cohort grades, and the last group represents above average grades.	(0 = less than 2.75**, 1= greater than 2.75 and less than 3.35, 3 = greater than 3.35)	PUDP
Prior Socialization Contexts			
High School Racial Context	The percentage of same-race peers within the high school context.	Continuous	CCD & PSS
STEM Major			
Computer and Mathematical Sciences	Student declared a Computer and Mathematical Sciences major in Fall 99	(0= No, 1= Yes)	PUDP
Life & related Sciences	Student declared a life sciences major in fall 99	(0= No, 1= Yes)	PUDP
Physical Sciences	Student declared a physical sciences major in fall 99	(0= No, 1= Yes)	PUDP
Social Sciences	Student declared a social sciences major in fall 99	(0= No, 1= Yes)	PUDP
Engineering**	Student declared an engineering major in fall 99	(0= No, 1= Yes)	PUDP
Structural Diversity			
Cohort-level racial composition	The number Latino students in each STEM subfield divided by the total number of students in each STEM subfield for the first year of enrollment at each institution.	Continuous	PUDP

Note: ** Indicates reference category

Model Specifications

Several steps were taken to determine whether the assumptions underlying the multinomial logistic regression specification were appropriate for this study. First, I assessed whether the sample size requirements were met by examining the case-to-variable ratio for each model where the preferred ratio was 20 cases to each variable. The final two models (*M4 and M5*); reported in Table 30 and 31, met the sample size requirements for a multinomial logistic regression of 10 cases to one and exceed the preferred 20 cases to one variable suggested by Hosmer et al. (2013).

Next, I tested the overall relationship, or fit, of each model using the Hosmer-Lemeshow test of goodness-of-fit test with 10 groups (Hosmer et al., 2013). The Hosmer-Lemeshow test statistic was used to determine whether the final models were an improvement over the baseline models, which only included the constant. While the Hosmer-Lemeshow test for goodness-of-fit is a common method used for assessing goodness-of-fit for logit models, recent simulations suggest that this test statistic is sensitive to the number of groups used to estimate the test statistic (Hosmer et al., 2013). As an additional check, I also examined the predicted and observed counts table. The final models (*M4* and *M5)* used to estimate Latino STEM retention produced non-significant Hosmer-Lemeshow p-values, indicating that the model adequately fits the data. Examination of the table of predicted and observed counts also show few differences.

Results and Discussion

Table 27 provides a demographic profile of Latino students in the sample. A side-by-side comparison of STEM and non-STEM students is used to determine whether there are salient differences between students who enter STEM relative to those who do not. The total sample of Latinos was evenly balanced between female and male students. Rates of entry into STEM, however, are heavily gendered, with men entering STEM at higher rates than women. While this finding is consistent with national trends and previous literature (Bonous-Hammarth, 2000; NSF, 2014), these differences are much smaller than expected and may reflect the broad definition of STEM used in this study. It is likely that this difference would have shifted in favor of Latinas had the definition of STEM included health sciences and secondary education STEM majors. Pell Grant eligibility, a proxy for socioeconomic status, did not seem to differ according to entry into STEM. Similarly, there was virtually no difference in the types of high schools that produce Latino STEM aspirants. Interestingly, however, a larger proportion of STEM students attended private high schools outside of the U.S. mainland. Further inspection of these data show a larger proportion of Latinos who attended private schools in Puerto Rico entering STEM compared to non-STEM majors. Students attending non-mainland institutions were among those excluded from analysis because they did not participate in PSS. Graduation rates show modest differences between STEM and non-STEM Latinos. While there were slightly more STEM students departing the university, this may be a product of a larger issue related to unique factors impacting retention for Latino men (Saenz & Ponjuan, 2009).

Only 64.6% of Latino STEM students received a degree or were still enrolled after six years. The majority of Latinos in STEM pursue engineering degrees, but less than half of these students graduate with an engineering degree or are still enrolled after six years (see Table 28). About a third of Latino STEM majors who began degrees in engineering exit the university without receiving any degree (Rincón, 2015). Still, engineering accounts for the largest proportion of STEM degrees received by Latinos after six years. Most STEM fields lose at least half of their initial Latino enrollees. Finally, non-STEM majors receive 14.1% of initial Latino STEM majors.

Table 27.
Comparison of First Year STEM and Non-STEM Latinos

	STEM (N=327)		Non-STEM (N=653)	
	N	%	N	%
Gender				
Male	186	56.9	347	46.1
Female	141	43.1	405	53.9
Pell Status				
Received Pell grant	102	31.2	221	29.4
Did not receive Pell grant	225	68.8	507	67.4
High School				
Public	247	75.5	484	74.1
Private	80	24.5	169	25.9
Graduation Status				
Graduated	204	62.4	426	65.2
Did Not Graduate	117	35.8	215	32.9
Still Enrolled	6	1.8	12	1.8

Source: Author's calculations

Table 28.
Distribution of First and Final Major for Latino STEM Students

	Initial STEM		*STEM Degrees Received*	
	N	%	N	%
Life & related Sciences	75	25.3	33	11.1
Mathematics and Computer Sciences	33	11.1	17	5.7
Physical Sciences	7	2.7	1	0.3
Social Sciences	60	20.2	44	14.8
Engineering	122	41.1	53	17.8
Non-STEM	0	0.0	42	14.1
All Majors	297	100.0	190	64.0

Source: Author's calculations

Racial Context

Table 29 provides a brief illustration of the university and high school racial contexts for Latinos in STEM. On average, Latino students experienced slightly more diverse environments within their field of study (e.g. engineering, mathematics and computer sciences, physical sciences, life sciences, and social sciences) than in the university context as a whole. Latino students came from high schools contexts that were racially homogenous, regardless of high school type, and attended high schools where less than 20% of the student body was Latino. The standard deviations indicate that the concentration of same-race peers, specifically percent Latino, varies the most for students attending public high schools. In comparison, Latino STEM students who attended private high schools experienced the least exposure to same-race peers prior to entering a college campus. The experience of Latinos in this sample is unlike that of Latinos nationwide. Currently, the Latino experience in K-12 is characterized by intense hyper-segregation, where Latino students experience the most segregation from Whites and higher levels of concentrated poverty than any other racial minority group (Orfield, Bachmeier, James & Eide, 1997).

Table 29.
Racial Composition Measures for Latinos in STEM

	M	Min	Max
Institutional Variables			
Percent Latino[5] within STEM Subfield	3.71 (1.91)	1.0	9.0
Campus-level Percent Latino	3.52 (1.55)	1.82	5.30
High School Variables			
High School Percent Latino	16.58 (23.05)	0.00	0.99
Private HS	11.08 (14.13)	0.00	0.77
Public HS	17.48 (24.18)	0.00	0.99

Note: Standard deviations are in parentheses. *p < .05, **p < .01, ***p < .001
Source: Author's calculations

Table 30 and Table 31 present the odds ratios from the multinomial logistic regression models for Latino STEM students. Odds ratios represent the relative odds of an outcome occurring relative to the referent outcome, persisting in any STEM degree. An odds ratio greater

[5] Results estimated without the outlier generated comparable results. On average, Latinos in STEM experience more diversity in their fields of study than in the larger context of the university.

than 1 is considered a positive increase in the relative odds of the comparison outcome occurring as the variable increases, whereas an odds ratio less than 1 represents a decrease in the odds of the comparison outcome occurring as the variable increases.

Results indicate that prior socialization contexts, as measured by students' high school racial contexts, do not moderate the racial context that students experience on campus. That is, there is no change in the relationship between cohort-level Latino composition and persistence in college when high school racial context is included (see *M4)* or excluded from the model (see *M5*), nor is there a unique contribution of high school racial context to student departure from the university or departure from STEM. The lack of variability in pre-college segregation experiences may explain why there is no evidence that precollege exposure is related to structural diversity once in college or to subsequent educational outcomes. About half of Latino STEM students in this sample attended a high school with a student body composed of less than 5% Latinos; 75% of students attended high schools where the Latino student body was less than 20%; and only 8% attended Latino majority high schools. Conversely, 70% of Latinos attended schools that were majority White. This distribution has three probable explanations: 1) students attending majority-minority high schools are not being prepared to enter selective public institutions, let alone STEM programs, 2) the geographical context of this study highlights the unique experience of growing up Latino in the Midwest and Mid-Atlantic and 3) university recruitment practices may reflect recruitment targeting high yields schools that tend to privilege predominantly white high schools.

These findings, however, say little about the interactions Latino students are having with White students on the college campus. It is possible that Latino students at PWIs re-learn what it means to be a member of a racial minority on college campuses as they become targets of racial discrimination on campus. For example, Garcia, Johnson, Garibay, Herrera and Gallardo (2011) find that Latinos are increasingly the targets of racially themed parties. Moreover, results from this study lend little insight into the experiences of Latinos in STEM who grow up in racially segregated high schools. Future research is needed in this area.

Table 30.
Odds Ratios for Multinomial Logistic Regression for Latinos in STEM Who Left the University

	Left University				
	M1	*M2**	*M3****	*M4****	*M5****
Male	1.61	1.95*	1.60	1.58	1.59
	(.43)	(.60)	(.53)	(.53)	(.53)
Life & Related Sciences		1.06	1.09	1.10	1.08
		(.36)	(.40)	(.40)	(.40)
Mathematics and Computer Sciences		1.11	1.30	1.30	1.32
		(.49)	(.61)	(.62)	(.63)
Physical Sciences		.74	.49	.49	.43
		(.93)	(.63)	(.64)	(.56)
Social Sciences		2.11	2.15	2.14	2.24
		(.07)	(.96)	(.96)	(1.05)
Below average GPAs			9.41***	9.37***	9.43***
			(4.29)	(4.27)	(4.30)
Average GPAs			2.93*	2.91*	2.93*
			(1.38)	(1.37)	(1.38)
HS Racial Context				1.01	-
				(.03)	-
Cohort racial composition				.84*	.84*
				(.07)	(.07)

Note: Standard errors are in parentheses. *p < .05, **p < .01, ***p < .001
Source: Author's calculations

Table 31.
Odds Ratios for Multinomial Logistic Regression for Latinos in STEM Who Left STEM

	Left STEM				
	M1	*M2**	*M3****	*M4****	*M5****
Male	1.72	1.78	1.80	1.84	1.86
	(.63)	(.76)	(.76)	(.78)	(.79)
Life & Related Sciences		.74	.73	.71	.72
		(.38)	(.37)	(.37)	(.38)
Mathematics and Computer Sciences		.91	.90	.88	.78
		(.55)	(.55)	(.54)	(.52)
Physical Sciences		8.42*	9.40*	9.05*	9.49*
		(7.81)	(8.80)	(8.50)	(8.90)
Social Sciences		1.18	1.18	1.19	1.10
		(.69)	(.69)	(.70)	(.66)
Below average GPAs			1.40	1.40	1.44
			(.70)	(.70)	(.72)
Average GPAs			1.91	1.91	1.95
			(.91)	(.92)	(.94)
HS Racial Context				.98	-
				(.04)	-
Cohort racial composition				1.15	1.21
				(.12)	(.12)

Note: Standard errors are in parentheses. *p < .05, **p < .01, ***p < .001
Source: Author's calculations

Limitations

As the results from this study are considered, a few limitations should be kept in mind. First, by estimating probabilities, this study aims to identify potential relationships between the benefits accrued from an increase in structural diversity for Latinos and Latino students' persistence to STEM degrees. This study does not suggest any causal relationships because students in this study were not randomly assigned to a particular university environment (e.g. diverse, not diverse). As such, the results have limited generalizability in terms of the institutions represented in the study, the students who enroll at these institutions, and the geographical context of these institutions. Second, it is especially important to note the selection bias associated with the process by which students choose colleges and colleges choose students (i.e. this choice is not random) (Bowen and Bok, 1998). With these constraints in mind, the generalizability of these findings should be limited to these particular contexts and should not be applied to all students in all higher education settings. The replication of this study in different contexts is needed to confirm its generalizability across populations and contexts.

Third, because data limitations do not allow for disaggregation within racial/ethnic groups, thus Latino populations were treated as a homogenous group, which may conceal important educational sub-group differences among Mexican, Puerto Rican, Cuban, and Central and South American groups. Future data collection strategies should attempt to allow for disaggregation across sub-groups. These differences should especially be considered for educational contexts with a higher proportion of Latinos, as well as regional contexts that have more ethnic diversity. As Latinos constitute an ethnic group that can identify as multiple racial groups, differences between Afro-Latinos, mestizos, and White-identifying Latinos are likely to arise.

Finally, while the models attempt to capture the potential effect of structural diversity in STEM subfields and across the campus at these six PWIs, the secondary nature of the data limits the ability to capture students' actual campus racial climate experiences. Future research should seek to include these important variables. Along the same lines, because this study does not capture how students respond to potential negative climates on campus, and because students have various ways of coping, this study does not make such claims. Therefore, it is reasonable to assume that students who are able to seek help or create safe spaces at PWIs will persist in spite of negative racial climates.

Conclusion

In conclusion, there are few differences between the precollege backgrounds of Latino students who enter STEM or non-STEM fields of study. In particular, there was virtually no difference in the types of high schools that produced Latino STEM aspirants. When examining whether prior racial socialization contexts moderate the relationship between structural diversity and student persistence to degree I find that prior racial socialization contexts, as measured by students' high school racial contexts, do not moderate the racial context that students experience on campus. That is, there is no change in the relationship between cohort-level Latino composition and persistence in college when high school racial context is included or excluded from the model, nor is there a unique contribution of high school racial context to student departure from the university or departure from STEM. This non-effect is likely due to the fact that Latino students in the sample came from racially homogenous high schools, regardless of type (e.g. private or public), and attended high schools where less than 20% of the student body was Latino. The experience of Latinos in this sample is unlike that of Latinos nationwide.

Chapter 6

Conclusion

In conclusion, the findings from this three-study dissertation indicates that Latino entrance and persistence in STEM is racially stratified. Latinos are among the least to enter STEM, especially high status STEM fields, and are amongst the highest to leave STEM fields. Structural diversity on college campuses is also found to have modest implications for student retention to degree.

In Chapter 3, I find that Latino entrance and persistence in STEM fields varies by subfield. However, Latino students consistently have lower rates of entrance and persistence in high status STEM fields when compared to their White and Asian peers. Given the number of Black and Latino non-STEM degree aspirants switching into STEM fields, results also indicate that there is an opportunity to recruit STEM students in college. At the intersection of ethnicity and gender, this study confirms the large gender disparity among Latino STEM matriculants, however, there are no statistical gender differences in persistence to degree. In fact, the Latino STEM gender gap narrows or reverses when examining degree attainment. Finally, this study does not find any statistical differences in STEM entrance or persistence by Pell eligibility. While findings from this study risks stereotyping students of color and women as being less interested in STEM fields or less likely to succeed once enrolled, it is important to understand student trajectories in order to inform efforts to promote student success despite the many obstacles Latinos encounter.

In Chapter 4, I find that the racial and ethnic composition of STEM fields is related to Latino student departure from the university, but not STEM. I also find differences in how students responded to structural diversity as measured at the cohort, upper-division, and graduate-level. While the effect of structural diversity at the cohort-level on Latino departure from the university is modest, results confirm the positive relationship found between greater Latino representation and increased educational success (Hagedorn, 2007). Results also suggest that Latinos in STEM may be more sensitive to their proximal environment. That is, Latinos in STEM may be more responsive to changes in the racial composition within their own cohort compared to increases in diversity for upper-division peers or graduate students. Further, the study found that the structural diversity "effect" for Latinos was not the same for their Black and White peers. This study is important for better understanding how institutions can create environments that are more conducive to REM learning and success. Findings from this study contribute to the literature on the important role of structural diversity in student outcomes, and support previous findings highlighting the important role of same-race peers for Latinos in STEM (Seymour & Hewitt, 1997).

Finally, in Chapter 5, I find that there are few differences between the precollege backgrounds of Latino students who enter STEM or non-STEM fields of study. In particular, there was virtually no difference in the types of high schools that produced Latino STEM aspirants. When examining whether prior socialization contexts moderates the relationship between structural diversity and student persistence to degree I find that prior socialization contexts, as measured by students' high school racial contexts, do not moderate the racial context that students experience on campus. That is, there is no change in the relationship between cohort-level Latino composition and persistence in college when high school racial context is included or excluded from the model, nor is there a unique contribution of high school racial context to student departure from the university or departure from STEM. This non-effect is likely due to the fact that Latino students in the sample came from racially homogenous high schools, regardless of type (e.g. private or public), and attended high schools where less than 20% of the student body was Latino. The experience of Latinos in this sample is unlike that of Latinos nationwide.

Implications

Collectively, findings from this study can inform future research, practice, and policy.

For Research

Results from Chapter 3 echo previous calls for researchers to disaggregate for within group differences in STEM (Ong, Wright, Espinosa, & Orfield, 2011). While a growing body of research has examined the double-bind of being a dual minority in STEM for women of color, future research should seek to examine differences and cumulative disadvantage by examining the intersections of race and ethnicity and gender with other "isms" that plague society such as class differences, differences by ability, differences by sexual orientation, differences by citizenship status, and English language abilities, among others.

Results from Chapter 3 suggest that Latino students are switching into STEM fields at a considerable rate. While these numbers are small, this finding suggests an opportunity to better understand what prompts student's decisions to switch into STEM majors. Further, it is equally important to understand why non-STEM majors do not switch into STEM fields.

Results from Chapter 3 also suggest that Latinos may be experiencing some unique challenges as problematic as the gender differences that favor males. While gender differences in persistence at the campus-level were only found to be statistically significant in the social sciences, the data depict a large share of Latino men who exit the university altogether when leaving STEM. Some explanations for this may be related to the differential impact of the weed-out system on men, where men are less likely to seek out supportive peer groups or help

(Seymour, 1997). Failure to seek support in an often unwelcoming STEM environment may disproportionately affect Latino males, a group that has been associated with coping with academic hardships through self-reliance (Gloria, Castellanos, Scull & Villegas 2009). Future research is warranted to better understand this phenomenon.

Findings from Chapter 4 indicate that there is promise in extending Hurtado's campus racial climate framework to capture nested nature of climates. Future research should aim to assess the cumulative experience of racial climates, as well as the cumulative nature of various climates that make up the larger campus environment.

Findings from Chapter 4 also suggest that future studies should seek to examine the impact of structural diversity on institutions and STEM environments with different levels of diversity at the institutional and department levels. For example, minority serving institutions created with specific missions of serving historically excluded students of color (e.g. Historically Black Colleges and Universities and Tribal Colleges), as well as those developed in response to shifting demographics at PWIs (e.g. Hispanic Serving Institutions) can provide a unique context in which to study campus racial climate for student retention within STEM, capturing both diversity in structural diversity and legacy of exclusion.

Beyond the structural diversity of MSIs, scholars point to several MSI attributes that lead to student success including higher levels of faculty mentorship and accessibility (Perna et al., 2009; Eagan et al., 2011), same-race role models (Hurtado et al., 2010), and supportive environments (Perna et al., 2009), which speak to the behavioral and psychological contexts of the campus racial climate framework. Further, in a case study of Spellman College, Perna and colleagues (2009) find that potential barriers associated with STEM departure for African American students are mitigated by the institutional practices such as a cooperative peer culture facilitated by small classrooms, student-faculty interactions, and structured research opportunities on and off campus. As such, future studies on STEM students that incorporate the various dimensions of the campus racial climate, and MSIs appear to provide a prime opportunity for such research.

For practice

Results from chapter 3 speak to the need to design interventions that target issues that arise at the intersections of these important social identities. For example, STEM access programs can target women of color into STEM, as this has consistently been found to be a point of intervention for Latina women. Along the same lines, interventions are needed in response to the differential impact of the weed-out system on men. These interventions may include providing academic and mental health services to all students, thus relieving student’s burden for seeking out support when needed.

Results from Chapter 3 also suggest that Latino students are switching into STEM fields at a considerable rate. This finding presents another avenue for increasing the number of under-represented students in STEM by recruiting students at the undergraduate level. This opportunity can be facilitated through the creation of interdisciplinary STEM courses that can introduce students to STEM fields and careers. Information-focused interventions at the college level should not seek to replace early information interventions that seek to increase STEM aspirations for traditionally underrepresented groups, but rather they should serve as a complimentary effort to get more REM students into STEM fields

For policy

Results from Chapter 4 suggest the need for universities to revisit admissions policies in order to limit the tokenization of Students of Color at PWIs, and specifically within STEM fields. This is especially important for constructing an incoming class, as findings from this study suggest that students are more sensitive to their proximal environments.

Findings from Chapter 5 suggest that universities may be limiting their recruitment to high yield high school, often synonyms with White high schools, and may be overlooking student potential at minority majority schools. Postsecondary institutions seeking to diverse their STEM student bodies should evaluate their recruiting practices to ensure that they are looking for promising students equitably.

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Appendix A: Classification of Instructional Programs

Table 32. SESTAT Science and Engineering fields

CIP Family	
Computer & Mathematical Sciences	
(11)	**Computer & Information sciences**
	Computer & Information Sciences
	Computer Science
	Computer Systems Analysis
	Information Services & Systems
	Other Computer & Information Sciences (30.0801)
(27)	**Mathematical Sciences**
	Applied Mathematics
	Mathematics, General
	Operations Research
	Statistics
	Other Mathematical Sciences
Life & Related Sciences	
(01)	**Agricultural & food sciences (01)**
	Animal Sciences
	Food Sciences & Technology
	Plant Sciences
	Other Agricultural Sciences
(26)	**Biological Sciences**
	Biochemistry & Biophysics
	Biology
	Botany
	Cell & Molecular Biology
	Ecology
	Genetics, Plant & Animal
	Microbiology
	Nutritional Science
	Pharmacology, Human & Animal
	Physiology, Human & Animal
	Zoology
	Other Biological Sciences
	Biological & Physical Sciences (30.0101)
(03)	**Environmental Life Sciences**
	Environmental Science Studies

	Forestry Services
Physical & Related Sciences (40)	**Chemistry (except Biochemistry)**
	Chemistry
	Earth Science, Geology & Oceanography
	Atmospheric Sciences & Meteorology
	Earth Sciences
	Geology
	Other Geological Sciences
	Oceanography
	Physics & Astronomy
	Physics
	Astronomy & Astrophysics
	Other Physical Sciences
	Other Physical & Related Sciences
Social & Related Sciences (45) (45)	**Economics**
	Economics
	Agricultural Economics (01.0103)
	Political & Related Sciences
	International Relations
	Political Science And Government
	Sociology & Anthropology
	Anthropology & Archaeology
	Criminology
	Sociology
	Public Policy Studies (44.0501)
	Philosophy Of Science
	Geography
	History Of Science
	Other Social Sciences
	Other Social Sciences
(5)	Area & Ethnic Studies
(16)	Linguistics
(42)	**Psychology**
	Educational Psychology

	Clinical Psychology Counseling Psychology Experimental Psychology Psychology, General Industrial And Organizational Psychology Social Psychology Other Psychology
Engineering (14)	**Aerospace & Related Engineering** Aerospace, Aeronautical & Astronautical (49.0101) **Chemical Engineering** Chemical Engineering **Civil & Architectural Engineering** Architectural Engineering Civil Engineering **Electrical & Related Engineering** Computer & Systems Engineering Electrical, Electronics & Communications Engineering **Industrial Engineering** Industrial Engineering **Mechanical Engineering** Mechanical Engineering **Other Engineering** Agricultural Engineering Bioengineering & Biomedical Engineering Engineering Sciences, Mechanics And Physics Environmental Engineering Engineering, General Geophysical Engineering Materials Engineering, Including Ceramics & Textiles Metallurgical Engineering Mining & Minerals Engineering Naval Architecture And Marine Engineering Nuclear Engineering

	Petroleum Engineering Other Engineering
Non-Science & Engineering	
(52)	**Management & Administration** Agricultural Business & Production Accounting Business Administration & Management Business, General Business & Managerial Economics Financial Management Other Business Management/Administrative Services
(51)	**Health & Related (These fields are included in non-S&E for bachelor's and master's programs only)** Audiology & Speech Pathology Health Services Administration Health & Medical Assistants Health & Medical Technologies Medical Preparatory Programs Medicine Nursing (4 years or longer) Pharmacy Physical Therapy & Other Rehabilitation Public Health, Including Environment Other Health & Medical Sciences
(13)	**Teaching & Education** Education Administration Computer Teacher Education Counselor Education & Guidance Elementary Teacher Education Mathematics Teacher Education Physical Education & Coaching Pre-Elementary Teacher Education Science Teacher Education Secondary Teacher Education Special Education Social Science Teacher Education Other Education
	Social Service & Related Social Work

	Other Philosophy, Religion, Theology
(15)	**Technology & Technical**
	Computer Programming
	Data Processing Technology
	Electrical & Electronics Technologies
	Industrial Production Technologies
	Mechanical Engineering-Related Technologies
	Other Engineering-Related Technologies
(52)	**Sales & Marketing**
	Business Marketing/Marketing Management
	Marketing Research
(24)	**Arts, Humanities & Related**
	English Language, Literature & Letters
	Other Foreign Languages & Literature
	Liberal Arts & General Studies
	History
	Dramatic Arts
	Fine Arts
	Music
	Other Visual & Performing Arts
	Other Non-Science & Engineering
(04)	Architecture & Environmental Design
	Other Conservation, Renewal Natural Resources
(52)	Actuarial Sciences
(09)	Communications
(09)	Journalism
	Other Communications
(43)	Criminal Justice & Protective Services
	Home Economics
(22)	Law, Pre-Law, Legal Studies
(25)	Library Sciences
(31)	Parks, Recreation, Leisure, & Fitness Studies
(44)	Public Administration
	Other Public Affairs
	Other Fields Not Listed