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Predicting Latina/o STEM Persistence at HSIs and non-HSIs

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Introduction

One of the most recognized dilemmas in the U.S. is the need for more education and training in science, technology, engineering, and mathematics (STEM). In 2007, Congress passed the America COMPETES Act, authorizing a number of governmental agencies to develop STEM programs at all levels of education. The Act was reauthorized in 2010 with additional requirements for enhancing the STEM educational pipeline for underrepresented minorities (URMs). In particular, the National Science Foundation (NSF) was authorized to provide additional funding to Minority Serving Institutions (MSIs), including Historically Black Colleges and Universities (HBCUs) and Hispanic Serving Institutions (HSIs). Enhanced support for HSIs is imperative since in 2005-2006, they enrolled approximately 50% of all Latina/o undergraduate students, awarded nearly 40% of all bachelor's degrees to these students, and granted 30% of all STEM degrees to Latina/o undergraduates (Dowd, Malcolm, & Bensimon, 2009). As such, HSIs have the potential to increase the number of STEM degrees awarded to Latina/o students.

In 2006, Latina/o students earned 7.7% of all science and engineering bachelor's degrees compared to white students who earned 64.7% (NSF, 2009). As indicated by legislation such as the America COMPETES Act, this disparity in STEM degree attainment for Latina/o students is a growing concern. The U.S. Census Bureau (2008) predicts that Latinas/os will represent 30% of the U.S. population by 2050 when the job market for careers in science and technology is likely to be in high demand. Latinas/os and other URMs must be educated and trained to fill these gaps in the job market. Few studies, however, have focused on the persistence of Latina/o students in STEM majors and fewer have attempted to explore the potential impact of attending a HSI. With the increase in the number of campuses attaining HSI status, research is needed to

understand how these institutions can contribute to STEM degree completion for Latinas/os. Additionally, empirical research is needed to understand the factors that predict persistence for Latina/o college students pursuing STEM majors.

The purpose of this study was to test whether Nora's (2003) Model of Student Engagement for Latina/o students can predict the factors that contribute to the persistence of Latina/o students who aspire to major in STEM. Logistic regression analysis was employed to determine the relationship of 16 independent variables with one dichotomous dependent variable measuring persistence within a STEM major. Using Nora's (2003) Model of Student Engagement, the stated hypothesis was that for Latina/o college students, there is a significant relationship between precollege demographic and push/pull factors, academic and social experiences, cognitive and noncognitive outcomes, institutional allegiance, and fourth-year persistence in a STEM major. Furthermore, this study sought to determine if HSIs are significant predictors of persistence for Latina/o students who aspire to STEM majors.

Background

A number of studies have examined factors that predict "success" for students in STEM majors. Some have examined first-year persistence while others have examined graduation as an indicator of success. Indicators of academic integration, including adjustment and academic achievement, have also been examined for students in STEM majors. Although the dependent variable has been defined broadly, several predictors of "success" in STEM majors have emerged.

Persistence in STEM

A number of student background and precollege characteristics have been determined to predict the persistence of students in STEM majors. Using logistic regression, Crisp, Nora, and

Taggart (2009) found that females of all races are less likely than males to complete a degree in STEM, and Asian American students are more likely to complete a degree in STEM when compared to white students (Crisp et al., 2009). Being Latina/o, however, does not significantly predict students' likelihood of completing a STEM degree (Crisp et al., 2009). Crisp et al. (2009) also found that SAT math scores and high school percentile contribute to the variance in STEM degree completion for students of all races. The American Association for the Advancement of Science (AAAS, 2001) concurs that standardized test scores and high school ranking influence bachelor's degree completion for URM STEM students. In a more recent study, Chang, Sharkness, Newman, and Hurtado (2010) confirmed the significance of SAT scores on all students' likelihood of persisting in a STEM major but did not find a significant effect of high school GPA or number of years spent taking mathematics or science in high school.

Empirical studies have also determined that academic and social experiences are important indicators of persistence for students pursuing STEM majors. Crisp et al. (2009) concluded that first-semester college GPA is correlated with STEM degree completion for all students. Joining an academic club or organization is also a significant indicator of first year persistence for biomedical and behavioral science students (Chang, Cerna, Han, & Sàenz, 2008) and increases the likelihood of persisting through to the fourth year of college for all STEM majors (Chang et al, 2010). Multiple studies have also found that participation in an undergraduate research program has a positive effect on STEM persistence, particularly for URMs. Perna et al. (2009) argue that for African American women in STEM, undergraduate research programs not only promote interest in STEM research and careers but also provide financial support that allows them to persist and succeed. Similarly, Hurtado, Cabrera, Lin,

Arellano, and Espinosa (2009) conducted a series of focus groups with URM STEM students involved in undergraduate research programs and concluded that exposure to research improves their understanding of science concepts and increases their likelihood of pursuing graduate or professional level research careers.

Academic Integration in STEM

Researchers have also looked at various indicators of academic integration for students pursuing STEM majors. Using data from the Cooperative Institutional Research Program (CIRP) at UCLA, Cole and Espinoza (2008) determined that time spent studying is positively related to the academic achievement of Latina/o STEM students. Cole and Espinoza (2008) also reported that faculty support and encouragement are positively correlated with academic achievement for Latina/o STEM majors. Similarly, Perna et al. (2009) argued that for African American women at one HBCU, faculty encouragement is important in promoting student academic success in STEM. Through a series of focus groups, Perna et al. (2009) learned that faculty members at Spelman College not only strive to develop curriculum that encourages academic achievement but they also make themselves highly accessible to students. In addition to faculty support, Hurtado et al. (2007) found that receiving peer support and advice from upper-class students is positively correlated with a sense of academic adjustment for first-year URMs in STEM.

Barriers to Persistence and Academic Integration

In addition to studying factors that contribute to the "success" of students in STEM majors, research suggests that several factors may be negatively correlated with the persistence and academic integration of these students. Seymour and Hewitt (1997) suggest that a negative campus climate may hinder the persistence of URMs in STEM majors. Chang et al. (2008)

found that as institutional selectivity increases at HSIs and PWIs, the first year persistence of URM STEM students decreases; however, the first year persistence of URM STEM students increases as the selectivity increases at HBCUs. In addition to institutional selectivity, Chang, Eagan, Lin, and Hurtado (in press) reported that URM science students who have a high science identity and who experience higher instances of negative racial interactions are less likely to persist in their major than students who experience lower levels of negative racial interactions.

Cole and Espinoza (2008) discovered that for Latina/o STEM students, studying with other students and attending diversity functions are negatively correlated with academic performance. They posited that these activities minimize "time on task," which may be detrimental to the academic success of Latina/o STEM students. As reported by Perna et al. (2009), African American women at Spelman College feel that despite the supportive peer environment they experience at their institution, social conflicts often arise with friends who are not in STEM majors because they may not understand the expectations and rigor of STEM courses. These conflicts could potentially hinder the persistence of African American women in these majors. Hurtado et al. (2007) concluded that for URMs in science, students' perceptions of a hostile racial climate and students' perceptions of a highly competitive environment are negatively correlated with their ability to adjust academically to campus in their first year. Enrollment at a selective institution is also a negative predictor of academic adjustment and sense of belonging for first-year URMs in science (Hurtado et al., 2007).

Despite the abundance of studies that have looked at factors affecting the persistence and academic integration of students pursuing STEM majors, few studies have focused primarily on Latina/o students in these majors. Additionally, Crisp et al. (2009) suggested that more research be conducted to determine the role of HSIs in ensuring equitable outcomes for Latina/o STEM

students. Although their findings suggest that Latina/o students are well represented in STEM majors at HSIs, they encouraged researchers to continue to test current persistence models as they pertain to Latina/o students at HSIs (Crisp et al., 2009).

Persistence of Latina/o Students

The theoretical model for this study is based on Nora's (2003) Model of Student Engagement for Latina/o students and incorporates the factors that predict persistence and academic integration for STEM students. The theoretical framework proposed by Nora (2003) has six major components to consider when studying the persistence of Latina/o college students. The first is *precollege factors/pull factors* including precollege ability, psychosocial factors, financial assistance and need, encouragement and support from family, and environmental pull factors. The second component is a *sense of purpose and institutional allegiance*, which incorporates aspects of educational aspirations and commitment to attending a specific institution. The third major component is *academic and social experiences*, including interactions with faculty, involvement in learning communities, social experiences, mentoring experiences, validating experiences, and experiences with the campus climate. The fourth major aspect is *cognitive and noncognitive outcomes* including academic performance, intellectual development, and noncognitive gains. The fifth component is *goal determination and institutional allegiance*, which includes degree attainment and institutional commitment. The sixth and final element is *persistence*, or re-enrollment in an institution of higher education.

The Model of Student Engagement for Latina/o students is supported by years of empirical research on the persistence of Latina/o students (Nora, 2003). Based on a series of interviews, Hernandez (2000) concluded that familial support, peer support, faculty and staff support, involvement, sense of community, and personal interactions with people on campus

make a positive difference to the retention of Latina/o undergraduate students. Haro, Rodriguez and Gonzales (1994) also interviewed Latina/o students in order to better understand their decisions to persist in a four-year university in California and concluded that encouragement and support from family was an important indicator or persistence. Haro et al. (1994) also discovered that a majority of Latina/o students work part-time jobs and commute to campus, both of which are identified as "pull factors" by Nora (2003). Mentoring has also been identified as an influential factor in persistence decisions of Latina/o students (Arellano & Padilla, 1996). Several scholars have also concluded that a hostile campus racial climate may affect Latina/o students' adjustment to campus, sense of belonging, and persistence (Gloria & Kurpius, 1996; Hurtado, 1994; Hurtado & Carter, 1997; Hurtado & Ponjuan, 2005; Yosso, Smith, Ceja, & Solórzano, 2009). For example, Gloria and Kurpius (1996) found that negative perceptions of the campus climate affects the persistence of Latina/o students. Similarly, Nora and Cabrera (1996) concluded that prejudice and discrimination indirectly affects the persistence of students of color.

One aspect of persistence in higher education that needs further attention is the role that HSIs play in predicting the persistence of Latina/o students. Defined by the 1998 reauthorization of the Higher Education Act (HEA), HSIs are accredited, degree-granting institutions that have at least 25% full-time equivalent (FTE) enrollment of undergraduate Latina/o students (Laden, 2004). Currently, HSIs represent a small percentage of all colleges and universities, six percent of all higher education institutions in 2003-2004, but they enroll nearly 50% of all Latina/o college students (Santiago, 2006). Thus far, researchers have determined that HSIs are not producing equitable outcomes for Latina/o and other students of color (Contreras, Malcom, & Bensimon, 2008) and Latina/o students who attend HSIs are less engaged than Black students

who attend Historically Black Colleges and Universities (HBCUs) (Nelson Laird, Bridges, Morelon-Quainoo, Wiliams, & Holmes, 2007). Similar effects are evident for URMs in STEM: Black STEM aspirants report significantly more faculty support at HBCUs than those at PWIs, however, Latina/os STEM aspirants do not report significantly more faculty contact and support at HSIs (Hurtado, Eagan, Tran, Newman, Chang & Velasco, in press). Although there is a growing body of literature focused on the outcomes associated with attending a HSI, much work is needed in this area. This study sought to contribute to what we know about persistence of Latina/o students with an emphasis on the role that HSIs may play.

Methodology

Sample

Data for this study were drawn from the Cooperative Institutional Research Program's (CIRP) 2004 Freshman Survey (TFS) and 2008 College Senior Survey (CSS). The Higher Education Research Institute (HERI) at UCLA collects TFS data from first year students prior to the start of their fall term and CSS data at the end of their fourth year. Grants from the National Institutes of Health (NIH) and National Science Foundation (NSF) provided funding to target MSIs, including HSIs, that had a reputation for successfully graduating underrepresented students, including Latinas/os, in STEM majors. Additionally, institutions with undergraduate research programs supported by NIH and NSF were targeted. These strategies yielded an institutional sample size of 160 colleges and universities. The sample for this study, n=810, included all Latina/o students who, in 2004, aspired as freshmen to major in a STEM discipline.

Descriptive statistics revealed that 56% of the Latina/o students in the sample persisted in a STEM major in 2008. Additionally, 63% of the Latina/o STEM students in the sample are female and a majority was high achieving in high school, as indicated by 71% who had average

high schools grades of "A." A large percentage of the sample (43%) received $3000 or more worth of loans in their first year of college, a third (30%) worked 11 or more hours (for pay) per week during high school, and 81% had "some" or "major" concerns about financing their college education. In regard to involvement while in college, 18% participated in an undergraduate research program and 56% joined a club or organization related to their major. Of the respondents in the sample, 17% attended a HSI.

By institutional type, the descriptive statistics varied slightly, although *t* tests revealed that only a few differences between HSIs and non-HSIs were significant. The number of female students was significantly different with 71% of the Latina/o STEM students at HSIs being female compared to 61% at non-HSIs ($p < .01$). A smaller percentage of the students at HSIs (28%) received $3000 or more worth of loans in their first year of college compared to non-HSI students (46%) ($p < .01$). Additionally, participation in an undergraduate research program was significantly different with 8% of Latina/o students at HSIs participating compared to 20% of Latina/o students at non-HSIs ($p < .01$). Table 1 provides means and standard deviations for the entire sample.

Variables

The dependent variable was a dichotomous measure from the CSS that asked students to indicate their final or most recent undergraduate major. The variable was recoded to include only those majors in STEM including biological sciences, chemistry, mathematics, engineering, and computer science. Since the sample only included students who intended to major in a STEM discipline in their freshman year, a positive answer indicated that the student persisted in STEM and a negative answer implied that the student had departed from STEM.

The 16 independent variables were included based on Nora's (2003) Model of Student Engagement for Latina/o students. *Precollege factors/pull factors* included gender, average high school grades, and standardized test scores. Additional *precollege factors/pull factors* included whether respondents received more than $3,000 worth of loans that must be repaid in order to pay for educational expenses, whether respondents worked more than 10 hours per week, and whether respondents had financial concerns.

Sense of purpose and institutional allegiance included a factor measuring the latent trait *college reputation orientation*. The three-item factor was identified by CIRP using Item Response Theory (IRT) and is intended to measure the degree to which students value academic reputation and future career potential as a reason for choosing their college. (Sharkness, DeAngelo, & Pryor, 2010). The scale had a Cronbach's alpha score of .746 for this sample.

Academic and social experiences included two single items and three factors. The two observed variables included whether students participated in an undergraduate research program (i.e., MARC, MBRS, REU) and whether students joined a club or organization related to their major. The three factors were also identified in previous research regarding cross-racial interactions (Hurtado, et al. 2007; Sáenz, Ngai & Hurtado, 2007), indicating that they are good measures of the latent traits of interest. The first, *positive cross-racial interactions*, includes six individual items and measures a student's sense of positive interactions with peers of other races/ethnicities. The second construct, *negative cross-racial interactions*, includes three items and is used to measure a student's sense of negative interactions with peers of a different race/ethnicity (see also Sharkness et al., 2010 for confirmation of these constructs). Both had high levels of reliability for the sample as indicated by Cronbach's alpha scores of .886 and .768, respectively. The third construct, *faculty support and guidance*, measures the quality and extent

to which students and faculty engage in relationships that foster mentoring, support, and guidance (see Sharkness et al., 2010 for the student-faculty interaction construct). This scale includes nine individual items and had a Cronbach's alpha score of .887 for this sample.

Cognitive and noncognitive outcomes included average college grades and *goal determination and institutional allegiance* included the CIRP identified construct, *sense of belonging*. This scale includes three items and measures a student's sense of academic and social integration on campus (Sharkness et al., 2010). The Cronbach's alpha score for this scale was .874. All scales were developed using principal axis factoring with promax rotation. The individual items and factor loadings for all scales are found in Appendix 1. The last block included two single item institutional variables, including a HSI variable and a variable measuring institutional selectivity (average institutional standardized test scores). Appendix 2 includes information about variable coding.

Data Analysis

Binary logistic regression was run in order to determine the influence of the 16 independent variables on the persistence of Latina/o students in STEM. Categorical predictors, including financial concerns, hours spent working during high school, and amount of aid received, were first recoded into binary variables. Then options for handling missing data were considered. A majority of the missing values (30%) were in the composite SAT scores. As such, ACT scores were first converted to SAT equivalent scores, which brought the number of missing cases to 14.7%. The remaining missing values were then replaced using the expectation maximization (EM) algorithm. The EM algorithm is the preferred technique over listwise deletion or mean replacement since it employs maximum likelihood estimation techniques and

uses the data available in order to impute the missing values (Allison, 2002; McLachlan & Krishnan, 1997).

Multicollinearity was then checked using the tolerance scores produced by a linear regression model with the same variables as those used in the logistic model (Menard, 2002). The tolerance scores were above .80 throughout the model except when institutional selectivity entered the model. Since HSIs tend to be less selective institutions, this variable was highly correlated (in a negative direction) with institutional selectivity (-.581). Student level test scores were also highly correlated with institutional selectivity since institutional selectivity is determined by averaging student level test scores. All three variables were preserved since they are important indicators of persistence with this sample. Logistic analysis was run using SPSS 18 and evaluation of the model was determined by observing the beta weights, standard errors, p values, and odds ratios. Delta-p statistics for the model are also reported.

Limitations

There are several limitations worth mentioning. The main limitation was related to the use of secondary data, which limits the research questions and analysis to variables on the survey. As with any preexisting survey, the items may not always be good measures of the desired variables. For example, several aspects of Nora's (2003) Model of Student Engagement, including support from family, mentoring experiences, and validating experiences, were not included in the model due to limited items on the TFS 2004 and CSS 2008 that could measure these experiences. The second major limitation to this study was related to the number of Latina/o students in the sample attending a HSI. Since the HSI sample was so small, it was not possible to compare predictors of STEM persistence for Latina/o students attending a HSI and those attending a non-HSI. The relatively small sample size of Latina/o STEM students was also

a limitation since the individual Latina/o groups (i.e., Puerto Rican, Mexican American) could not be disaggregated. Additionally, all STEM majors were aggregated for this study, despite the fact that science, math, and engineering majors may have different college experiences. Finally, the point of departure, as indicated by the dependent variable, is unknown, making it difficult to when those students changed majors. That is, if students changed majors very early in their college career, it is more difficult to interpret college environmental effects. Future research will help to entangle these factors with three time points of college experience data.

Results

Logistic regression analysis revealed the influence of *precollege factors/pull factors, sense of purpose and institutional allegiance, academic and social experiences, cognitive and noncognitive outcomes,* and *goal determination and institutional allegiance* on the persistence of Latina/o STEM majors. Table 2 displays the parameter estimates and significance values for the model. The overall model was significant ($x^2 = 112$, df = 16, $p < .001$) and yielded correct predictions for 67.5% of the total sample and 76.4% of the persisters. The model revealed that for Latina/o students, the likelihood of persisting in a STEM major is positively influenced by standardized test scores, participation in an undergraduate research program, participation in a club or organization related to their major, average college grades, and a student's sense of belonging. For Latina/o students, however, the likelihood of persisting in a STEM major is negatively affected by negative cross-racial interactions and faculty support and guidance.

The delta-p statistics reveal that for Latina/o students, a 100-point increase in standardized test scores increases the likelihood of persisting in a STEM major by 3.54%. Joining a club or organization related to STEM also increases the likelihood of persisting by 14.87% while participating in an undergraduate research program increases the likelihood of

persisting by 19.51%. Latina/o students who had higher college grades and a greater sense of belonging in their fourth year of school were also more likely to persist in STEM.

Results also revealed that an increase in negative cross-racial interactions decreases the likelihood of persistence for Latina/o STEM students. Since causality cannot be inferred, given the research design, it cannot be concluded that negative cross-racial interactions cause students to depart from STEM, but a significant association between the two variables does exist. Surprisingly, an increase in student-reported faculty support and guidance is associated with a lower likelihood of persisting in a STEM major. This may suggest that the more assistance a STEM aspirant receives the lower likelihood they will stay on STEM until the fourth year. Or more likely, students who departed a STEM major have more faculty support in their non-STEM major than those who persisted.

Discussion and Conclusions

The findings from this study contribute to what we know about the persistence of Latina/o students in STEM majors. Additionally, this study is one of few to test Nora's (2003) Model of Student Engagement, although the model appears well-suited for understanding underrepresented students (Hurtado, et al., 2007). Although Nora (2003) proposes several *precollege factors/pull factors* that may influence the persistence decisions of Latina/o students, academic preparedness, as determined by standardized test scores, was the only significant variable to increase the likelihood of persistence for this sample. Unfortunately, Latina/o students have been found to lag behind their White counterparts in regards to achievement on standardized tests such as the SAT/ACT (Contreras, 2005; Valencia, 2008). Institutions of higher education, therefore, must find ways to support the precollege preparedness of Latina/o students interested in pursuing STEM majors. For example, academic bridge programs, such as

Upward Bound, may help Latina/o students increase their math and science proficiency prior to taking entrance exams and prior to applying for enrollment. By taking responsibility for preparing Latina/o students prior to entering postsecondary education, institutions can help to increase the likelihood of persistence for aspiring STEM students.

Despite Nora's (2003) claim that *precollege factors*/*pull factors* such as work responsibilities and financial concerns may hinder persistence of Latina/o students, these variables were not significant predictors of persistence for Latina/o students in STEM at four-year colleges. This may mean that Latina/o students in our sample have been resilient, despite outside pressures from work as well as tangible and intangible financial concerns. Additionally, these variables were measured in the first year (fall 2004) and may not have been strong enough to influence persistence until later years. Future research should continue to test the influence of these variables at different career points, in a variety of contexts, and using a variety of measures.

The second component that Nora (2003) proposed as significant to persistence decisions of Latina/o students, *sense of purpose and institutional allegiance,* did not emerge as a significant indicator of persistence in this study. The "college reputation orientation" scale was used to measure this aspect of the model, which may not be a good indicator of the respondents' sense of purpose or institutional allegiance. The third component of the model, *academic and social experiences,* did prove to be significant for predicting the likelihood of persisting in a STEM major.

Similar to previous research on underrepresented students in STEM, joining a club or organization related to major was an important indicator of persistence for Latina/o STEM students (Chang et al., 2008; Chang et al., 2010; Hurtado et al., in press). This may be due to

increased exposure to academically related activities, such as departmental seminars and science conferences, as a result of membership. Joining an academically related club or organizational may also increase Latina/o students' sense of belonging (Hurtado & Carter, 1997). This is an important finding for faculty and administrators interested in retaining more Latina/o STEM students since it suggests that students should be encouraged to join departmental clubs and organizations. Additionally, departments should be encouraged to support student-run organizations, both financially and administratively, and faculty should be encouraged to advise these organizations.

Participation in an undergraduate research program was also related to persistence for Latina/o STEM students. As found in previous studies, students who participate in structured research programs are often retained at higher levels and pursue graduate school and careers in STEM in greater numbers (Barlow & Villarejo, 2004; Hurtado et al., 2009; Perna et al., 2009). Previous studies, however, have not focused specifically on Latina/o students. This study confirms that previous findings are consistent for Latina/o STEM students and suggests that faculty and program administrators recruit more Latina/o students to participate in undergraduate research programs. Additionally, faculty need institutional support for obtaining grants that support undergraduate research and should be encouraged to pursue these opportunities. Overall, faculty need more institutional support for developing and maintaining programs that hold high promise for identifying talent and graduating Latina/o science majors (Hurtado, et al., in press).

Negative cross-racial interactions were negatively related to the persistence of Latina/o STEM students in this study. As suggested by previous research, negative perceptions of the campus racial climate and experiences with prejudice and discrimination may hinder Latina/o student persistence (Gloria & Kurpius, 1996; Nora & Cabrera, 1996; Hurtado, et al., 2007). The

negative relationship may mean that Latina/o STEM students have fewer cross-racial interactions in their courses and in their departments. STEM students may spend more time in isolation, either studying or conducting laboratory research, which would minimize the number of students they interact with. This is an area that needs further research in order to better understand the cross-racial interactions of STEM students.

Although early models of student attrition suggested that faculty interaction is a vital aspect of persistence in postsecondary education (Tinto, 1993) this study begins to suggest that variations and quality of faculty interaction exist and may vary by major, and race/ethnicity. An increase in faculty support and guidance is associated with a lower the likelihood of Latina/o STEM students persisting. Although this finding may seem counterintuitive, it must not be interpreted to mean that a greater level of faculty interaction causes students in STEM majors to depart. Rather it may mean, that those students who departed actually tended to rely more heavily on faculty support and guidance. As mentioned, one of the limitations of this study is that the point of departure is unknown, therefore, students who departed from a STEM major may have become more involved with faculty after they made the decision to switch majors. Additionally, those who persisted may rely less on faculty for all areas of support (e.g. emotional). This effect of faculty support was over and above the effects of participating in undergraduate research, a productive form of faculty engagement that contributes to persistence. Still, it is important to further investigate the kinds of support that STEM Latina/os receive in different contexts that will help them achieve their goals..

In this study, the fourth component of Nora's (2003) Model of Student Engagement, *cognitive and noncognitive outcomes,* was measured by average college grades, which significantly increased persistence for Latina/o STEM students. Average college grades,

however, are rather narrow in their measure of academic ability. Additionally, previous studies have argued the importance of noncognitive outcomes in the persistence decisions of Latina/o students (Hernandez, 2000; Longerbeam, Sedlacek, & Alatorre, 2004). Future research, therefore, should continue to explore a variety of outcomes for STEM students, including self-efficacy and social agency.

The fifth component of the model is *goal determination and institutional allegiance,* which was measured by sense of belonging. Sense of belonging was positively related to persistence for Latina/o students in STEM majors. This implies that when students feel a greater sense of belonging, they may be more likely to persist. Consistent with previous research regarding Latina/o sense of belonging, this study implies that greater levels of academic and social integration may be related to higher levels of retention (Hurtado & Carter, 1997; Hurtado & Ponjuan, 2005; Maestas, Vaquera, & Muñoz Zehr, 2007). For faculty and administrators concerned with Latina/o student retention in STEM, a greater focus on enhancing sense of belonging should be considered. This may be attained through department level orientations, creating peer academic communities for pre-majors and existing majors, faculty mentoring programs, and academic advising.

This research study was also intended to explore the contribution that HSIs have on the persistence of Latina/o students in STEM majors. Although there was not a significant difference in the persistence rates of Latina/o students at HSIs compared to non-HSIs, the significant disparities are worth mentioning. The large discrepancy between the number of Latina/o students participating in an undergraduate research program at HSIs (8%) compared to Latina/o students at non-HSIs (20%) is alarming. In a report issued by HERI, Hurtado et al. (2004) reported that 64.8% of students at HSIs attend institutions with NIH programs on their

campus such as Minority Access to Research Careers (MARC). This finding, therefore, may imply that institutions in our sample have not been able to identify these high potential Latina/o students for research opportunities. As studies continue to emphasize the efficacy of these programs in predicting graduation of URMs in STEM, institutions must continue to find ways to support these programs and actively recruit talented students to participate in them. Future research should continue to explore the factors that facilitate STEM degree completion among Latina/o students.

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Table 1
Means and Standard Deviations

	Means (S.D.)
Dependent Variable	
STEM Persistence	.56 (.50)
Precollege/Pull Factors	
Gender (Female)	.63 (.48)
Average High School Grades	6.91 (1.15)
Standardized Test Score	11.60 (1.68)
Received $3,000 or More in Loans	.41 (.50)
Worked (For Pay) More than 11 Hours per Week During High School	.29 (.45)
Financial Concerns	.80 (.41)
Sense of Purpose/Institutional Allegiance	
College Reputation Orientation	.12 (.83)
Academic and Social Experiences	
Participated in Undergraduate Research Program	.18 (.39)
Joined a Club or Organization Related To Major	.56 (.50)
Positive Cross-racial Interactions	.16 (.85)
Negative Cross-racial Interactions	-.01 (.85)
Faculty Support and Guidance	-.02 (.96)
Cognitive and Noncognitive /Outcomes	
Average College Grades	5.25 (1.67)
Goal Determination/Institutional Allegiance	
Sense of Belonging	-.01 (.94)
Institutional	
Institutional Selectivity	11.78 (1.26)
HSI	.17 (.38)

Table 2
Logistic Regression Model Predicting Persistence in STEM Major

	ß	S.E.
Gender (Female)	.147	.167
Average High School Grades	.030	.075
Standardized Test Score	.145*	.059
Received $3,000 or More in Loans	.073	.164
Worked More than 11 Hours per Week in High School	-.237	.169
Financial Concerns	.069	.204
College Reputation Orientation	.090	.097
Participated in Undergraduate Research Program	.885**	.230
Joined a Club or Organization Related To Major	.648**	.160
Positive Cross-racial Interactions	-.115	.103
Negative Cross-racial Interactions	-.381**	.099
Faculty Support and Guidance	-.352**	.095
Average College Grades	.137*	.051
Sense of Belonging	.304**	.095
Institutional Selectivity	-.147	.090
HSI	-.017	.248

*p < .01 ** p < .001

Appendix 1
Factor Loadings for Scales

Item	**Factor Loadings**
College Reputation Orientation	
College has a very good academic reputation	0.520
Grads gain admission to top grad/professional schools	0.753
Grads get good jobs	0.856
Positive Cross-racial Interactions	
Had intellectual discussions outside of class	.840
Shared personal feelings and problems	.835
Had meaningful and honest discussions about racial/ethnic relations outside	.773
Dined or shared a meal	.771
Studied or prepared for class	.689
Negative Cross-racial Interactions	
Had guarded interactions	.657
Felt insulted or threatened because of your race/ethnicity	.717
Had tense, somewhat hostile interactions	.810
Faculty Support and Guidance	
Help in achieving your goals	.810
Encouragement to pursue graduate/professional study	.660
An opportunity to work on research project	.546
Advice and guidance about your educational program	.776
Emotional support and encouragement	.740
A letter of recommendation	.616
Help to improve your study skills	.639
Feedback about your academic work (outside of grades)	.704
An opportunity to discuss coursework outside of class	.661
Sense of Belonging	
I feel I have a sense of belonging to this campus	.873
I feel I am a member of this college	.849
I see myself as part of the campus community	.790

Appendix 2
Coding of Variables

Variables	**Scale**
Dependent Variable	
STEM major (CSS): biology, biochemistry or biophysics, botany, environmental science, marine (life) science, microbiology or bacteriology, zoology, aeronautical or astronautical engineering, civil engineering, chemical engineering, computer engineering, electrical engineering, industrial engineering, mechanical engineering, astronomy, chemistry, earth science, mathematics, physics	0 = Not Marked 1 = Marked
Precollege/Pull Factors	
Gender	0 = Male, 1 = Female
Average High School Grades	1 = D, 8 = A or A+
Standardized Test Score (SAT/ACT in 100-point Scale)	Range of 2-16
Amount of First Year's Educational Expenses Covered by Aid Which Must be Repaid	0 = $0-$2,999 1 = $3,000 or More
During Last Year in High School, Time Spent During a Typical Week Working (for Pay)	0 = 10 or Less 1 = 11 or More
Financial Concerns	0 = None, 1 = Some
Sense of Purpose/Institutional Allegiance	
Composite Measure of College Reputation Orientation	1 = Very Important 3 = Not Important
Academic and Social Experiences	
Participated in Undergraduate Research Program	0 = No, 1 = Yes
Joined a Club or Organization Related To Major	0 = No, 1 = Yes
Composite Measure of Positive Cross-racial Interactions	1 = Very Often, 5 = Never
Composite Measure of Negative Cross-racial Interactions	1 = Very Often, 5 = Never
Composite Measure of Faculty Support and Guidance	1 = Frequently, 3 = Not at All
Cognitive and Noncognitive /Outcomes	
Average College Grades	0 = No, 1 = Yes
Goal Determination/Institutional Allegiance	1 = D, 8 = A or A+
Composite Measure of Sense of Belonging	1 = Strongly Agree 4 = Strongly Disagree
Institutional	
Institutional Selectivity (Average SAT/ACT in 100-point Scale)	Range of 2-16
HSI	0 = No, 1 = Yes