1. *Latinx Students in STEM College Pathways: A Closer Look at Diverse Pathways through Hispanic Serving Institutions (HSIs)*

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Community colleges and Minority Serving Institutions (MSIs)—Hispanic Serving Institutions (HSIs), in particular—serve as key access points to postsecondary education for Latinx[1] students and provide several pathways for pursuing STEM (Science, Technology, Engineering, and Mathematics) degrees. Nearly 40% of all undergraduate students of color are enrolled in MSIs (Cunningham, Park, & Engle, 2014). HSIs, specifically, are federally defined as institutions with a Latinx student population of 25% or greater (Contreras & Contreras, 2015). However, unlike other MSIs, HSIs do not have a written mission or vision to serve or recruit Latinx students (Núñez, Hurtado, & Galdeano, 2015). Considering 60.8% of all Latinx students are enrolled in HSIs (Hispanic Association of Colleges and Universities, 2016) and nearly 50% of HSIs are two-year colleges (Excelencia in Education, 2014a), the overlapping institutional contexts of community colleges and HSIs are particularly important environments that impact the postsecondary experiences of Latinx students.

Forty percent of all Latinx undergraduate degrees are awarded by HSIs (Dowd, Malcom, & Macias, 2010), which are among the top 25 institutions of higher education that award degrees to Latinx students (Santiago, 2012). Given the potential that HSIs provide in terms of retaining Latinx students, it is important to consider how these institutions can better support Latinx students pursuing STEM degrees. This chapter provides a summary of current literature and empirical research on Latinx students entering STEM fields

through diverse college pathways. Additionally, this chapter highlights national trends among Latinxs in STEM at HSIs and specifically focuses on the community college context. The role of two-year HSIs is closely examined through an exploratory descriptive analysis of the most recent longitudinal nationally representative data available through the National Center for Education Statistics (NCES).

Literature Review

Hispanic Serving Institutions

HSIs are federally defined by the Higher Education Opportunity Act (HEOA) as accredited, degree-granting, public or private nonprofit institutions of higher education with 25% or more full time equivalent undergraduate Latinx students (Contreras & Contreras, 2015). Colleges and universities designated as HSIs are eligible to apply for federal grants through Title V also known as Developing Hispanic-Serving Institutions Program (Santiago, 2006). According to the Hispanic Association of Colleges and Universities (2016), there are 435 HSIs in the US serving more than 1.8 million Latinx undergraduate students, with 83% of HSIs concentrated in California, Texas, Puerto Rico, New Mexico, Florida, and New York. Forty six percent of HSIs are public two-year colleges, and 3.9% are private two-year institutions (Excelencia in Education, 2014a). In total, two- and four-year HSIs represent 12.9% of all nonprofit higher education institutions and enroll 21.9% of all students (Hispanic Association of Colleges and Universities, 2016).

Furthermore, higher education institutions with an undergraduate Latinx enrollment between 15 and 24.9% are identified as emerging HSIs (Excelencia in Education, 2015; Hispanic Association of Colleges and Universities, 2015; Santiago & Andrade, 2010). As of 2016, there are 33 states with at least one emerging HSI (Excelencia in Education, 2016). According to the U.S. Department of Education, there are 310 emerging HSIs; 34.5% of which are two-year institutions (Hispanic Association of Colleges and Universities, 2016). Thus, the number of designated HSIs is expected to grow significantly within the next ten years as the Latinx population continues to grow (Excelencia in Education, 2015; Hispanic Association of Colleges and Universities, 2015).

Community College Context

Between 1993 and 2014, Latinx enrollment in higher education increased 13 percentage points, from 22 to 35% (Pew Research Center, 2016). This

rise is attributed in part to the growing number of students of color enrolling specifically in community college (Provasnik & Planty, 2008). Latinxs, in particular, are more likely to attend community college than any other ethnic group (Balassone, 2013; Long, 2016). Almost half of all Latinx students, nearly 7 million, are enrolled in community colleges across the U.S. (Pew Research Center, 2016). In 2013, 22% of students enrolled in public community colleges were Latinx (Pew Research Center, 2016). Nationally, among Latinxs that attained STEM bachelor's degrees, 61% attended a community college at some point in their educational trajectories and 18% earned an associate's degree prior to obtaining their bachelor's degree (Malcom, 2010). Community colleges play a vital role in STEM education as they provide key access points to higher education for Latinxs (Hagedorn & Purnamasari, 2012; Packard, Gagnon, LaBelle, Jeffers, & Lynn, 2011; Provasnik & Planty, 2008; Salzman & Van Noy, 2014; Wang, 2013).

Underrepresentation in STEM

While literature on STEM students at the community college level is still emerging, empirical studies demonstrate that underrepresented students of color aspiring STEM degrees at community colleges are at a disadvantage when compared to students at four-year institutions (Grandy, 1998; Wang, 2015). Although Latinx students enter community colleges at higher rates, only a small percentage successfully transfer to a four-year university (Bailey, Jenkins, & Leinbach, 2005). These low transfer rates have been attributed to numerous factors: lack of support on behalf of the institution (Ovink & Veazey, 2011), high student to counselor ratios, ineffective advising, and remedial coursework (Crisp, Nora, & Taggart, 2009; Hagedorn & Purnamasari, 2012; Ovink & Veazey, 2011). Specifically, Crisp *et al.* (2009) found that a disproportionately large number of Latinx students are assigned or incorrectly placed in developmental or remedial courses. Lee, Flores, Navarro, and Kanagui-Muñoz (2015) also found a direct correlation between self-efficacy beliefs and persistence among students who were placed into remedial coursework. Further, Wang (2015) argues that community colleges have yet to develop pathways for STEM degrees in the same way that four-year universities have.

Among four-year institutions, the challenge of underrepresentation in STEM remains. Although historically underrepresented students enter college with interests in STEM fields at equal rates to their White and Asian counterparts, too few of these students successfully graduate with STEM degrees from four-year institutions (Bailey *et al.*, 2005; Huang, Taddese, &

Walter, 2000; Malcom, 2010). For example, Hurtado, Eagan, and Hughes (2012) analyzed data on the entering freshmen cohort of 2004 and found that only 29% of Latinx, 21.8% of African American, and 24.9% of American Indian students compared to 43% of White students, who intended to major in STEM actually completed a STEM four-year degree within four years. Latinx, African-American, and American Indian students only accounted for 14.7% of the total STEM degrees awarded in 2010 (Estrada *et al.*, 2016).

While academic preparation impacts student retention in STEM majors at the four-year level, educational settings and STEM climate are also central to the experiences of underrepresented students of color (Engberg & Wolniak, 2013; Garcia & Hurtado, 2011; Ong, Wright, Espinosa, & Orfield, 2011; Ovink & Veazey, 2011). Similar to the community college context, Latinx four-year STEM students are faced with a lack of institutional support (Hurtado *et al.*, 2007; Hurtado & Carter, 1997; Ovink & Veazey, 2011). Feelings of isolation, invisibility, and tokenism within predominantly White environments are common experiences among underrepresented students of color in STEM at four-year institutions (Byars-Winston, Gutierrez, Topp, & Carnes, 2011; Hurtado *et al.*, 2007; Hurtado, Newman, Tran, & Chang, 2010; Ong *et al.*, 2011; Orom, Semalulu, & Underwood III, 2013). Moreover, the traditional competitive nature of STEM programs also negatively impacts underrepresented students of color's adjustment to campus (Hurtado *et al.*, 2007, 2010) and hinders their persistence in STEM majors (Seymour & Hewitt, 1997).

In their study of four-year institutions, Hurtado *et al.* (2010) found that perceptions of hostile racial campus climates and highly competitive environments negatively impacted the academic adjustment of underrepresented students of color pursing STEM majors during their first year. Ong *et al.* (2011) define STEM disciplines as "meritocratic in nature and [their] focus on grades, classroom performance, and research results" ignores the "social realities of racism and sexism in science environments" (p. 183). As a result, underrepresented students of color, both undergraduate and graduate, commonly experience issues related to ethnic and gender discrimination, which impacts their sense of belonging on campus. Similarly, Orom *et al.* (2013) found that underrepresented medical students of color received less support and exposure to positive learning environments, experienced discrimination, and were more likely to perceive their race as having a negative impact on their medical school experience in comparison to their White peers.

The literature also identifies a positive link between supportive educational spaces and the persistence of underrepresented students of color in STEM (Cole & Espinoza, 2008; Hurtado *et al.*, 2007). Precollege summer

programs have been found to improve retention rates of student of color in STEM (Palmer, Maramba, & Elon Dancy Ii, 2011). For community college students in particular, strong support systems, engagement in introductory STEM courses, hands-on research, and faculty mentorship have been found to increase student retention in STEM (Morgan & Gerber, 2016; Myers, Starobin, Chen, Baul, & Kollasch, 2015; Wang, 2015; Wang, Sun, Lee, & Wagner, 2017). Similarly, college support STEM programs and research/laboratory opportunities for undergraduates at the four-year institutional level have proven to encourage STEM participation among underrepresented students of color (Byars-Winston *et al.*, 2011; Chang, Sharkness, Hurtado, & Newman, 2014; Hurtado *et al.*, 2007; Ong *et al.*, 2011). Lee *et al.* (2015) also found that Latinx students' participation in hands-on engineering opportunities led to greater self-efficacy, which increased confidence and intentions to persist in college.

Student relationships with faculty are also important predictors of STEM persistence (Byars-Winston *et al.*, 2011; Hurtado *et al.*, 2010; Ong *et al.*, 2011; Ovink & Veazey, 2011). Faculty that foster collective learning (Byars-Winston *et al.*, 2011) and validate students' identities as emerging scientists are instrumental in promoting STEM persistence (Ong *et al.*, 2011). Ovink and Veazey (2011) also draw attention to the role of academic advisors within college support programs. The hands-on mentoring approach of these advisors helps keep underrepresented students of color motivated and "on track" while providing them with social and cultural capital that allows them to pursue specific STEM careers (Ovink & Veazey, 2011). For community college students, faculty and academic advisors provide crucial psychological and instrumental support among underrepresented students pursuing STEM majors (Archuleta-Lucero, 2015; Packard *et al.*, 2011).

In their extensive examination of HSIs, Núñez *et al.* (2015) found these institutions more likely to have supportive campus climates with fewer incidents of racial and ethnic discrimination reported. Specifically, the greater visibility and representation of Latinx students, faculty, and administration at HSIs foster the possibility for creating supportive campus climates and increasing academic self-concept for Latinxs (Núñez *et al.*, 2015).

HSIs and STEM

Through a brief examination of the most recent nationally representative data, this chapter underscores the importance of understanding the role of HSIs as STEM pathways for Latinx students. A descriptive analysis will highlight the role of HSIs in STEM entrance and persistence and provide a na-

tional profile of STEM students attending HSIs. The data presented are derived from the 2004–2009 Beginning Postsecondary Students Longitudinal Study (BPS:04/09) available through the NCES. This data set is designed to investigate factors relevant to student success in college (e.g., enrollment, persistent, attainment). The BPS:04/09 is a nationally representative sample of approximately 16,100 first-time, first-year beginning students, conducted through three waves of data collection. The first wave in 2003–2004 and two follow-up surveys collected additional data in three-year interviews, 2006 and 2009 (Cominole, Riccobono, Siegel, & Caves, 2010). Through descriptive statistics computed using NCES PowerStats, we outline the role of two- and four-year HSIs in STEM access.

STEM Entrance

Table 1.1. STEM[1] entrance by race/ethnicity at HSIs[2]

	Two-year HSIs	Four-year HSIs	All HSIs
White	5.3	1.3	2.9
African-American	8.3	3.5	5.7
Asian American/Pacific Islander	26.4	5.9	12.1
Latinx	49.8	44.9	47.4
All Students	14.6	6.3	9.7

[1] STEM fields include mathematics, sciences (including physical sciences and biological/agricultural sciences), engineering/engineering technologies, and computer/information sciences

[2] Federally designated Hispanic Serving Institution

Source: U.S. Department of Education, National Center for Education Statistics, 2003–2004 Beginning Postsecondary Students Longitudinal Study, Second Follow-up (BPS:04/09). Computation by NCES PowerStats Version 1.0

First, we examine the distribution of students entering STEM fields through HSIs in Table 1.1. We define STEM students as those that declare a major in mathematics, sciences (including physical sciences and biological/agricultural sciences), engineering/engineering technologies, and/or computer/information sciences at any point during the six-year college enrollment period. Among all beginning postsecondary students who entered a STEM field at some point over a six-year period, only 9.7% start at an HSI. Larger proportions of two-year versus four-year STEM students begin at HSIs, with 14.6% of STEM students starting at two-year HSIs (public and

private nonprofit) compared to 6.3% of STEM students starting at four-year HSIs (public and private nonprofit).

Across racial groups, we see that two-year HSIs are key STEM access points, not only for Latinx students, but for other students of color as well. Two-year HSIs enroll 49.8% of Latinx, 26.4% of Asian/Pacific Islander, and 8.3% of African-American students in comparison to their White peers with only 5.3% enrolling at HSIs. Considering that HSIs contribute to nearly half of the Latinx STEM entrants at two-year institutions, it is imperative to look toward two-year HSIs as an underutilized opportunity for addressing underrepresentation in STEM for Latinx and other students of color.

HSI STEM Student Profile

Reflective of the significant institutional stratification by race/ethnicity and by income in the US educational system (Carnevale & Strohl, 2013), HSIs are disproportionately less selective four-year institutions and/or community colleges and Latinx postsecondary students are concentrated within HSIs (Núñez, 2017). In particular, HSIs educate a large proportion of students of color from urban school districts as more than 50% of these institutions are community colleges located in urban settings (Excelencia in Education, 2014b). Therefore, we need to better understand the undergraduate profiles of those who enter STEM fields through HSIs. Table 1.2 highlights student characteristics among STEM entrants across two-year HSIs and non-HSIs.

Table 1.2. Profile of 2003–2004 beginning community college students who entered STEM[1] fields through 2009 at HSIs[2] and Non-HSIs, by selected student characteristics

	Two-year HSI	Two-year Non-HSI
Gender		
Male	64.6	70.7
Female	35.4	29.3
Parents' highest education		
High school diploma or less	45.5	37.9
Some college/voc. training but no degree	19.7	18.0
College degree	34.9	44.2

(Continued)

Table 1.2—Continued

	Two-year HSI	Two-year Non-HSI
Income group 2003–2004		
Lowest quarter	47.6	22.6
Middle two quarters	38.4	52.4
Highest quarter	14.0	25.1
High school GPA		
Below B	15.4	22.0
At least B	84.6	78.0
Remedial education		
Remedial course 2004: Any	36.3	27.0
Remedial course 2004: Math	30.6	20.2
Enrollment 2003–2004		
Full-time	42.1	55.9
Part-time	38.2	29.4
Mixed	19.7	14.6

[1] STEM fields include mathematics, sciences (including physical sciences and biological/agricultural sciences), engineering/engineering technologies, and computer/information sciences

[2] Federally designated Hispanic Serving Institution

Source: U.S. Department of Education, National Center for Education Statistics, 2003–2004 Beginning Postsecondary Students Longitudinal Study, Second Follow-up (BPS:04/09). Computation by NCES PowerStats Version 1.0

While many studies point to the low representation of women in STEM fields (Starobin & Laanan, 2008), we find through disaggregation that the proportion of females to males is higher among HSI STEM entrants in comparison to non-HSI STEM entrants. While the number of women entering STEM at two-year HSIs does not reach parity with the proportions of men, the percentage of women in STEM at HSIs (35.4%) is six percentage points higher than the proportion of STEM women at non-HSIs (29.3%). The socioeconomic backgrounds of students are an important consideration as literature has posited that HSIs, particularly community colleges, disproportionately serve first-generation, low-income, and nontraditional students

(Núñez, Sparks, & Hernández, 2011). Among HSI STEM entrants, only 34.9% of students had parents who had attained a college degree, equating to nearly 10 percentage points less than their STEM counterparts beginning at non-HSI two-year institutions. Similarly, the income distributions of STEM students at HSIs were concentrated in the lowest income bracket with almost half falling within this category and only 14% in the highest income bracket, which compares with 25% of students at non-HSIs who fall within the highest income bracket.

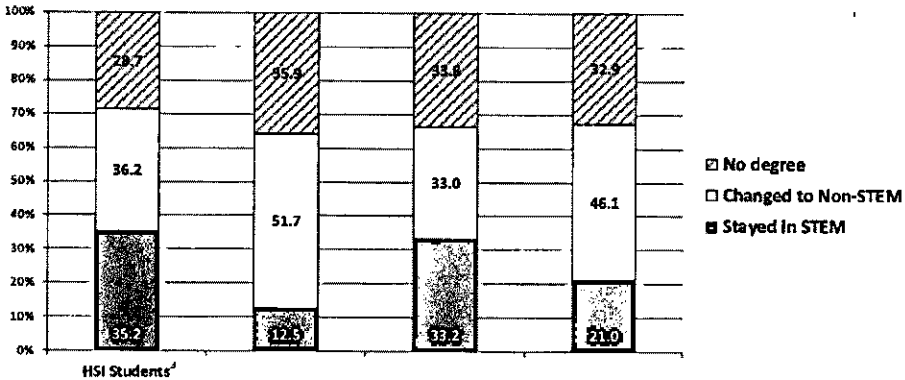
Precollege preparation is one of the most commonly cited factors influencing the postsecondary attainment among low-income and underrepresented students (Chang *et al.*, 2014; Crisp *et al.*, 2009). Two-year colleges and HSIs face the challenge of students entering with varying levels of access to the high-quality precollege learning experiences that prepare them for STEM undergraduate programs. There is a measureable difference of over six percentage points in the proportion of HSI STEM students who earn at least a B in high school (78%) as compared to the proportion of STEM students within this grade range (84.6%) attending non-HSI institutions. STEM students who enter postsecondary education at HSIs require remedial intervention at a much higher rate than their non-HSI STEM peers. The proportion of STEM HSI students requiring at least one remedial course in any subject is over 10 percentage points higher than their non-HSI peers, with 36.3 and 27%, respectively. Similarly, in math the proportion of STEM HSI students (30.6%) requiring at least one remediation course is over 10 percentage points higher than that of non-HSI STEM students (20.2%). Lastly, in terms of full-time enrollment, the proportion of HSI STEM (42.1%) who were enrolled full-time in 2003–2004 is over 13 percentage points less than the proportion of STEM students attending non-HSIs (55.9%).

STEM Persistence

We examined STEM persistence over a six-year period for those who started postsecondary education in 2003–2004. We concentrated on students whose first institution was a two-year HSI or two-year non-HSI, with a specific focus on Latinx students. Differences across these institution types were observed. At both two-year HSIs and two-year non-HSIs, Latinxs have significantly lower STEM persistence rates in comparison to their non-Latinx peers. Latinx students at HSIs have the lowest proportion of students who were retained in STEM (12.5%) overall, which is over 23 percentage points lower than their non-Latinx peers (35.2%) at these same institutions. Interestingly, we found similar gaps in STEM persistence at non-HSIs, but these differences are not

as profound at HSIs with 21 and 33.2% STEM persistence among Latinx and non-Latinx respectively. In addition, there are larger proportions of Latinx students who leave postsecondary education entirely (35.9% compared to 28.7% for non-Latinx students) and who persist in college but switch out of STEM majors (51.7% compared to 36.2% for non-Latinx students). Our findings confirm previous studies suggesting that graduation rates for Latinxs at HSIs are not equitable to non-HSIs.

Figure 1.1. STEM[1] persistence as of 2009 for 2003–2004 beginning two-year students by first institution HSI[2] status.



1 STEM fields include mathematics, sciences (including natural, physical sciences and biological/agricultural sciences), engineering/engineering technologies, and computer/information sciences

2 Federally designated Hispanic Serving Institution

3 HSI students includes race categories: White, African American, Asian American/Pacific Islander, American Indian, Other & more than one race

Source: U.S. Department of Education, National Center for Education Statistics, 2003-04 Beginning Postsecondary Students Longitudinal Study, Second Follow-up (BPS:04/09). Computation by NCES PowerStats Version 1.0

Source: Authors

Discussion

Our findings demonstrate that two-year HSIs are critical access points in the STEM pipeline for Latinx students and other students of color. While community colleges overall enroll women in STEM at higher rates, two-year HSIs are vital in broadening participation for women in STEM. In addition, we observed larger proportions of low-income, first-generation college students, and part-time students are concentrated within two-year HSIs. Socioeconomic factors are important considerations as they may require students to work full-time, which can inhibit the academic and social adjustment of STEM students (Hurtado *et al.*, 2010). While academic

preparation has been cited as one of the most important factors impacting STEM access and retention (Chang *et al.*, 2014; Crisp *et al.*, 2009; Engberg & Wolniak, 2013; Garcia & Hurtado, 2011), we found that two-year HSIs admit slightly larger proportions of STEM entrants with high GPAs (B or higher) in comparison with two-year non-HSIs. However, two-year HSIs had higher rates of students requiring remedial coursework, particularly in math. Early interventions in math and other STEM core courses are important for STEM advancement, especially within two-year colleges (Wang, 2015).

Unfortunately, our analysis of national data confirms that outcomes for Latinxs at HSIs are not equitable to their peers at non-HSIs (Contreras, Malcom, & Bensimon, 2008). STEM retention rates for Latinxs at two-year HSIs are 23 percentage points lower than their non-Latinx peers at two-year HSIs and nearly nine percentage points lower than their Latinx peers at two-year non-HSIs. While the literature we reviewed identifies the potentially positive educational features of and opportunities for HSIs to promote Latinx STEM persistence and attainment, scholars continue to call for more research to determine the role of HSIs in ensuring equitable outcomes for Latinx STEM students (Crisp *et al.*, 2009; Garcia & Hurtado, 2011). As Garcia (2017) argues, being a Hispanic "Serving" Institution goes beyond the metrics of Latinx persistence and attainment, but includes providing community engagement opportunities, positive campus climate, and support programs. Clearly there is an opportunity for HSIs, particularly two-year HSIs, to play a critical role in increasing Latinx representation in STEM and more work is needed to harness the potential of these unique contexts.

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Note

1. Latinx is used in place of Latino/a. Latinx serves as a gender-neutral term that is not limited by the gender binary ("Latinx," 2016).

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