Improving STEM Degree Attainment Rates:

Lessons from Hispanic Serving Institutions

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Abstract

Despite having fewer resources compared to Predominantly White Institutions (PWIs), specific Hispanic Serving institutions (HSIs) are *exemplary* producers of STEM degrees among underrepresented racial minority (URM) students, meaning that they produce more STEM degrees than expected when taking into account institutional resources and capacity. Using cross-case analysis, this study examines the strategies of 11 *exemplary* institutions, four of which are HSIs. While some strategies are shared with other institutions that have large minority enrollments, and across all 11 institutions, this paper focuses on the unique strategies that HSIs use to foster achievement and persistence among their undergraduate STEM aspirants. Findings suggest that (1) knowing and serving students well, (2) institutional receptivity to learning and improving, (3) hiring diverse faculty who care about teaching, and (4) outreach and  service to the surrounding community, are key practices HSIs employ in promoting students' success and persistence in STEM. The lessons learned from these HSIs offer insight for leadership at non-HSIs and emerging HSIs to identify appropriate context-specific strategies aimed at increasing STEM degree attainment, especially among URM students.

**Introduction**

Compared to other countries, the U.S. under-produces STEM graduates, and scientific advisors have suggested that institutions must increase baccalaureate attainments in order to remain competitive in a global economy (Olson & Riordan, 2012). With increasing racial/ethnic diversity in educational institutions, the U.S. will largely depend on institutions that serve large numbers of underrepresented (URM) groups to improve STEM degree productivity and diversify the scientific workforce (National Academy of Sciences, 2011). The Latinx community represents the nation's largest, youngest, and fastest-growing ethnic group, constituting 17.8% of the U.S. population, and are projected to comprise 30% of the U.S. population by the year 2050 (U.S. Department of Education, 2016). These demographic changes have implications for changing demographics within and across college campuses as well as U.S. trainees in science and technology.

The majority of Latinx students enrolled at four-year colleges and universities (62.3%), are concentrated in Hispanic Serving Institutions (HSIs), which are federally designated colleges and universities that enroll at least 25% Latinx students (Núñez, Hurtado, & Galdeano, 2015). Despite having access to fewer resources compared to predominantly white institutions (PWIs), and only constituting 9% of all colleges and universities, HSIs impressively produced 40% of the STEM bachelor's degrees earned by Latinx students in 2010 (Núñez, et al., 2015). HSIs' STEM degree productivity is especially remarkable when accounting for their limited resources: HSIs are typically limited in budget and endowment; tend to be highly dependent on state, federal, and municipal funds; and as a result, are generally under-equipped, under-staffed, and non-competitive in terms of employee salaries compared to PWIs (Núñez, et al., 2015). In addition to serving increasingly large shares of Latinx students, HSIs also serve students who have

historically had less access to rigorous high school preparation and higher education, enrolling a greater proportion of students from low-income, first-generation, and/or racial/ethnic backgrounds (Núñez et al., 2015). Still, HSIs have a significant regional presence and are often connected to their communities in a myriad of ways that benefit those racially/ethnically diverse communities.

HSIs may be largely responsible for producing the next generation of URM scientists, for despite the term *Hispanic-Serving*, their racial/ethnic enrollments are exceptionally diverse. In 2014-2015, HSIs enrolled 28% of Asian American, 16% of Black, 14% of American Indian, and 10% of white students nationally (Núñez et al., 2015). In fact, HSIs enroll a greater share of Black students in the U.S. than Historically Black Colleges and Universities (HBCUs) (16% compared to 10%) and a higher share of Native American students than Tribal Colleges and Universities (TCUs) (14% compared to 11%) (Hurtado & Alvarado, 2015). Considering the important role that HSIs play in creating access to postsecondary education and STEM bachelor's degrees for underrepresented groups, these are important institutional contexts for further inquiry that can result in lessons for other institutions.

## Purpose

The purpose of this study is to identify strategies unique to *exemplary* HSIs that result in relatively higher STEM degree attainment rates, especially among Latinx and other URM students. Through cross-case analysis, we compare the strategies found at HSIs with those present at seven other *exemplary* non-HSIs to determine how HSIs' practices differ or share similar characteristics across institutional types. We draw upon the perspectives of STEM faculty, STEM program directors, and administrative leadership at each institution in order to understand its organizational culture, structure, and context. We are particularly interested in

exploring how each HSI's institutional context uniquely shapes the strategies it employs, in order to provide context-specific recommendations that other HSIs, emerging HSIs, and non-HSIs can draw upon to increase STEM degree attainment rates among their URM students.

## Literature Review and Guiding Frameworks

In order to examine the strategies that HSIs use to broaden undergraduate participation in STEM, it is important to understand the history of HSIs and the diversity that exists within them. To describe HSIs in generalities reduces our capacity to make vital distinctions among them, which often leads to unrealistic and flawed implications for organizational strategies. That is, there is substantial variation across HSIs that researchers have begun to identify. Therefore, in the following section we provide: (1) a brief history of HSI federal designation, (2) discuss four important themes that inform an HSI's organizational identity, and (3) draw upon two typologies to differentiate and contextualize the HSIs in our study.

### Recent History of Hispanic Serving Institutions

As the Latinx population began to grow, Hispanic advocacy groups mobilized to urge the federal government to recognize HSIs in the same way that Historically Black Colleges and Universities (HBCUs)  had been recognized in the federal budget for support (Núñez et al., 2015). With the reauthorization of the Higher Education Act (HEA) in 1992, the government ultimately developed a federal designation for Hispanic Serving Institutions (HSIs), which recognized and created a competitive grant program aimed at providing support for capacity-building at HSIs (MacDonald et al., 2007; Santiago, 2006). Under this new legislation, a public or private, not-for-profit higher education institution that is accredited, degree-granting, and enrolls at least 25% Latinx students and at least 50% low-income students, could apply for federal designation as an HSI and receive federal funding through a Title V grant (Núñez, et al.,

2015). HSIs were further legitimized with 1998 HEA reauthorization, which loosened the federal

requirements for identification, recognized HSIs under Title V, and increased federal funding for

qualifying institutions (MacDonald et al., 2007). Since 1994, the number of HSIs has increased

dramatically from 189 to 409 and counting, as more campuses increase their Latinx enrollments

each year (Santiago & Galdeano, 2014).

However, unlike other Minority Serving Institutions (MSIs), such as Historically Black

Colleges and Universities (HBCUs) or Tribal Colleges and Universities (TCUs), HSIs were not

established with the specified mission to serve underrepresented students. Instead, HSIs have

historically been characterized by their enrollment patterns, such that any institution that

experiences an influx of Latinx students and meets the 25% enrollment requirement can apply

for federal HSI designation—irregardless of its authentic commitment to serve these students.

The question that arises is the extent to which institutions change, as their enrollments change,

since  the majority of HSIs began as Predominantly White Institutions (PWIs) (Hurtado &

Alvarado, 2015). This has led scholars to begin to examine an HSI's organizational identity,

which is what members perceive as being central, distinctive, and enduring to their organization

(Albert & Whetten, 1985), to determine the extent to which these institutions embrace a mission

to serve Latinx students.

**HSI's Organizational Identity**

In an effort to understand how an HSI constructs its organizational identity and enacts a

Latinx-serving mission, Garcia (2013) documented the cultural values and organizational

practices of a federally designated, four-year HSI. Through an in-depth case study that centered

the voices of students, administrators, faculty and student affairs staff, the study identified four

themes that characterized the HSI's core organizational identity as: (1) regionally focused, (2)

committed to the surrounding community, (3) dedicated to access, and (4) committed to serving a diverse population.

The HSI's regional focus was evident in that the institution's demographics reflected those of the surrounding community. The HSI was also a strong contributor to the surrounding community's economy, since its graduates tended to live and work in the area. Being regionally focused was intertwined with the HSI's commitment to the community, however, this was a separate theme because it emphasized the institution's tangible service learning and community partnerships, programs and services, which were designed to serve the community by connecting it to the HSI's resources. For example, several of the institution's facilities and centers were open to community members, research projects were designed to be sustainable in order to benefit the community, and partnerships were built with local school districts and community colleges as a way to develop students' competency to work with the diverse populations in the area.

In line with its regional focus and commitment to the community, the HSI was historically dedicated to creating access for the regional community. However, there were a number of growing tensions in maintaining this value in the midst of enduring fiscal crisis. While faculty and administrators described the HSI's commitment to creating access through its practice of intentionally enrolling large numbers of students of color, they also discussed the tension between maintaining access and the HSI's movement towards increased selectivity as a response to the state's economic crisis. Although the HSI was committed to developing students who arrived academically underprepared (60% of first-time freshmen), faculty discussed that a common sentiment among some faculty was that creating access for these academically underprepared students was undermining the institution's ability to maintain "quality" and "efficiency" (p. 114). Thus, while creating access has historically characterized the HSI, there is

a growing tension between maintaining this commitment and responding to pressures imposed

by its larger organizational environment, particularly in the area of increasing degree attainment.

Lastly, institutional members made sense of the HSI's identity by discussing its

racially/ethnically diverse student body, comprised primarily of Latinx and white students, along

with smaller proportions of Black, Asian, Persian and Armenian students. Garcia (2013) notes

how the HSI's student diversity was a direct result of its regional focus, commitment to the

community and dedication to access. All the participants in the study mentioned student diversity

and connected it to the HSI's identity. Some faculty and administrators even said that the HSI's

diversity is what attracted them to work at the institution in the first place. However, some Latinx

participants challenged the HSI's commitment to diversity by highlighting that the racial/ethnic

diversity of the faculty, staff, and administration did not reflect the student racial/ethnic diversity,

and that students of color did not graduate at equitable rates compared to white students.

Therefore, a commitment to diversity and student success may not be enacted across the

institution in ways that result in desired outcomes. We wish to expand on the four characteristics

found at a single institution case study (Garcia, 2013) by comparing multiple HSIs and non-

HSIs, and identifying the strategies evident in the HSIs  with relative success in STEM degree

attainments.

**Diversity within the HSI Category**

Because HSIs vary tremendously on various dimensions that shape their organizational

identity, they cannot be discussed as a monolith. Thus, we also explain the sample of HSIs in

further depth regarding their institutional characteristics. As research on HSIs has increased over

the last couple of decades, scholars have begun to disaggregate HSIs into various types; thus, we

draw on two typologies--Núñez, Crisp, and Elizondo's (2016) typology of institutional diversity

and Garcia's (2018) typology of organizational identities--in an effort to distinguish and further contextualize the HSIs in this study.

**Typology of institutional diversity.** While the Carnegie classification system is a useful tool to classify and compare higher education institutions, it does not identify HSIs as a distinctive institutional type, most likely because the criteria used to evaluate institutions under this system does not recognize the "unique nature of HSIs, the students they serve, their variety, and a host of other key characteristics" (HACU, 2012 as cited in Núñez, et al., 2015). However, in order to improve research on HSIs, it is essential to distinguish HSIs by institutional type, control, and geographic location. Therefore, we draw upon Núñez, Crisp, and Elizondo's (2016) typology of institutional diversity to highlight important aspects of the HSIs in our study. Núñez et al.'s (2016) typology identifies six clusters of HSIs: (1) Urban Enclave Community Colleges, (2) Rural Dispersed Community Colleges, (3) Big Systems Four-Year Institutions, (4) Small Communities Four-Year Institutions, (5) Puerto Rican Institutions, and (6) Health Science Schools.

Using this typology, three of the HSIs in this study can be categorized under Cluster 3: *Big Systems Four-Years*, which encompasses institutions that typically belong to state public institution systems, have large student enrollments, offer bachelor's degrees or higher, are public, are overrepresented in cities, contain an overrepresentation of full-time faculty, female students, and students receiving Pell Grant assistance, and have the lowest average graduation rates (Núñez et al., 2016). The fourth HSI in this study fits under Cluster 4: *Small Communities Four-Year*, which comprises private institutions that offer bachelor's degrees or higher, are often liberal arts colleges or religiously affiliated institutions, are typically located in urban and suburban areas, emphasize graduate education, have higher tuition and fees, receive little

government support, and have the highest graduation rates (Núñez et al., 2016). The HSIs are compared in the Results section and begin to differ somewhat from this typology in that they have relatively higher graduation rates compared to the national average and are efficient producers of Latinx STEM degrees.

**Typology of organizational identity.** In addition to categorizing the HSIs in this study based on institutional type, control and geographic location, we also draw on Garcia's (2018) typology of organizational identity to distinguish HSIs based on their organizational outcomes and organizational culture. A theoretical typology of HSI organizational identities (Garcia, 2018) suggests that an HSI can be further distinguished by the extent to which its members focus on organizational outcomes for Latinx students (i.e. graduation rates, graduate school enrollment patterns etc.), and the organizational culture that facilitates such outcomes. This typology identifies four types of HSIs: *Latinx-enrolling, Latinx-producing, Latinx-enhancing,* and *Latinx-serving,* with a *Latinx-serving* identity being the optimal type since it characterizes HSIs that move beyond simply enrolling Latinx students (focused only on the numbers who enter college), to producing equitable outcomes for them and maintaining an organizational culture that is supportive, welcoming and enhances their educational experiences.

An HSI that is *Latinx-enrolling* merely enrolls at least 25% Latinx students, but lacks an organization culture that supports its Latinx students and does not produce equitable organizational outcomes for those students. An HSI with a *Latinx-producing* organizational identity enrolls at least 25% Latinx students, produces significant—and perhaps even equitable— outcomes for its Latinx students, but lacks an organizational culture that supports and enhances their education. A *Latinx-enhancing* identity is characterized by a 25% minimum Latinx student enrollment and an organizational culture that enhances Latinx students' experiences on campus;

however, it does not produce equitable outcomes for its Latinx students. The ideal type of HSI is

one that possesses a *Latinx-serving identity*: it enrolls at least 25% Latinx students, enacts an

organizational culture that supports and enhances Latinx students' experiences on campus, and

produces equitable organizational outcomes for these students.

The Results section begins with distinguishing between the HSI campuses using these

typologies. Based on these typologies, moving forward, the four HSIs in this study will be

referred to as: **West Coast State University**, **Southeast State University**, **East Coast State

University**, and **Southern Private University**. The other institutional cases include two

predominantly white research institutions (PWIs) ( University of Southeast and Midwest State

University), two HBCUs (Mid-Atlantic University and Atlantic Southern State University), and

two institutions that had a strong Native American presence relative to most PWIs ( Northern

Mountain University and Central Plains State University). All campuses were selected using the

stochastic frontier analysis and efficiency scores that indicate data over time in STEM degree

productivity relative to campuses with comparable resources.  Each are shown with brief

descriptions in Appendix A. Detailed descriptions of the HSIs follow in the Methods section.

## Methods

We employed a multiple case study design and cross-case analysis techniques from the

grounded theory tradition to systematically capture patterns and meanings, and to develop

conclusions and theoretical contributions.

**Data source and sample**

To identify higher education institutions for this study, the research team used stochastic

frontier analysis on Integrated Postsecondary Education Data System (IPEDS) data among all

four-year, non-profit colleges and universities. The analysis identified "exemplary" producers of

undergraduate underrepresented racial minority (URM) STEM degrees, or institutions that did better than expected at producing STEM bachelor degree recipients given their resources, compared to similarly resourced peer institutions. Specifically, undergraduate degree completion data from IPEDS was averaged over several years (i.e, 2002, 2004, 2006, 2008, 2010, and 2012) while accounting for human capital, financial capital, and labor resources available at each institution. Efficiency scores were produced and institutions were compared within Carnegie classifications (for more details on the quantitative analysis, see Eagan, 2010).

Further, we also took into consideration URM student enrollment (in an effort to avoid campuses that had high efficiency scores but enrolled only a handful of URM students), admission selectivity, geographic diversity, availability of STEM intervention programs (e.g., HHMI funding, MARC, MBRS, IMSD), stability of leadership, and variability in institutional control. Web scraping campuses' websites occurred across a larger sample of institutions before selection to corroborate the quantitative analysis with STEM-related information. Web scraping also allowed the team to identify faculty, senior administrators, and program directors who were highly involved in STEM education efforts. The team used this list to help select individuals to participate in interviews during the site visits. After identifying institutions of high interest, we contacted a dean and/or senior administrator at each campus to determine whether we could gain access to the institution for the purposes of conducting a site visit. From these efforts, the research team began with a selection of six institutions in 2014, and conducted site visits for the the six campuses between 2014-2015. With additional funding from the Helmsley Foundation, the team conducted the remaining five site visits in 2016 for a total of 11 campus site visits from 2014-2016. The identified campuses are shown in Appendix A, along with efficiency scores for URM groups.

Cross-institutional analysis, along with multiple interviews per campus allowed for validation of the findings across sites as well as cross-validation of findings within institutions (Yin, 2013). To explore the institutional context for students at each campus, 20-25 STEM faculty, program directors, and administrators were interviewed over the course of 2-3 days, with a few interviews conducted via telephone/video conference. The individuals invited for participation were chosen because an examination of the institution's website demonstrated that these individuals were improving STEM teaching and learning or were engaged in innovative methods/work to support students in STEM. One-on-one interviews took place using a semi-structured interview protocol and interviews lasted roughly 60 minutes. Occasionally, a participant would invite another person from the university she or he thought would be helpful in answering questions; therefore, a few interviews had more than one person answering questions. The interview protocols aimed to elicit responses to questions regarding the nature of STEM support programs offered, the pedagogical approaches utilized in STEM classrooms, policies and structures that promote improved STEM teaching and learning, and how support for STEM students is coordinated.All interviews were audio-recorded, transcribed verbatim and loaded into MAXQDA software for coding.

The second component of data collection consisted of document collection and observation of the physical environment of the university. Items gathered varied in scope and included (but were not limited to) campus newspapers, STEM program brochures, and institutional and quantitative literacy manuals. This step in the data collection was taken in order to further our understanding of the activities, practices, and policies related to retention, diversity and student success in STEM education at each campus. Additionally, at times the team took

photos to document labs, active learning classrooms, or any physical environments that were related to our inquiry about STEM education success.

**HSI Case Descriptions**

Southeast State University is a Carnegie classified public R1 institution nestled in an urban city; it is among the top 10 largest universities in the nation with an undergraduate population of 41,038 students, of which 67% are Latinx, 12% are Black, 2% are Asian and 3% are students of two or more races. The six-year graduation rate for Latinx students (59%) and Asian students (64%) is higher than that of white students (50%), equal for American Indian students (50%) and moderately lower for Black students (42%). The institution is considered a higher transfer-in, primarily non-residential institution. Roughly 8% of undergraduate students live in college-owned housing. There are roughly 2,255 faculty members of whom 54% are full-time, with a student-faculty ratio of 27:1. Southeast State University also has a more diverse faculty, with 44.9% Latinx and 10.2% Black faculty. Additionally, Southeast State University has a number of grant-funded programs that serve URM students, including the Ronald E. McNair Research Scholars Program, Talent Search, Upward Bound, Living Learning Communities, and the Louise Stoke Alliance for Minority Participation (LSAMP) program.

East Coast State University is a Carnegie classified public R2 university located in an urban center with an undergraduate enrollment of 8,170. With 27% Latinx, 19% African American, 20% Asian, and 53% Pell-eligible students, East Coast State claims to be the most diverse campus in the nation. East Coast State University's six-year graduation rate is higher for its Latinx (68%) and Asian students (74%) than for its white students (64%), moderately lower for its Black students (55%), and substantially lower for its American Indian students (14%). The institution is not just in the city, but "of the city," indicating its close connection with the

surrounding urban community. East Coast State University's faculty is predominantly white

(42%), with only 7.8% Asian, 10.5% Latinx, 14.5% Black faculty. East Coast State University

has a number of grant-funded programs that serve URM students, including Ronald E. McNair,

Talent Search, Upward Bound, LSAMP, Geoscience Scholars Program, Living Learning

Communities, and the Minority Biomedical Research Support Program (MBRSP).

West Coast State University is a Carnegie classified public master's university with an

undergraduate enrollment of 22,157, of which 42% are Latinx, 23% are Asian, and 3% are Black

students. In descending order, West Coast State University's six-year graduation rate is 74% for

white students, 73% for Asian students, 62% for Latinx students, and 52% for Black students.

There are roughly 1,155 faculty members at West Coast State, of whom 49% are full-time, with

a student-faculty ratio of 28:1. The faculty are predominantly white (48.5%), with 21.4% Latinx,

17.4% Asian and 5.6% Black faculty. As a polytechnic university, West Coast State University,

values a 'learn by doing' pedagogical approach to teaching, learning, and practice. The campus

is primarily nonresidential with the majority of students commuting to campus and only 11% of

undergraduates living in college-owned housing. West Coast State University houses a large

number of grant-funded programs that serve URM students, including: Ronald E. McNair, Talent

Search, Upward Bound, Educational Opportunity Program, Learning Communities, LSAMP,

MBRSP, Science Scholars Enrichment, Maximizing Engineering Potential, Science Educational

Enhancement Services, and Minority Access to Research Careers, among others.

Southern Private University is a Carnegie classified private master's university with a

strong tradition as a Catholic university with a liberal arts focus. Its undergraduate student

population of 4,620, comprises 41% Latinx, 4% Black, and 3% Asian students. Southern Private

University's six-year graduation rate is 68% for Asian students, 62% for white students, 63% for

Black and Latinx students, and 60% for American Indian students. Despite the diversity of its

student body, the institution's faculty is overwhelmingly white (67.7%), with only 19.5% Latinx,

3.4% Black, and 2.7% Asian faculty. Compared to the other HSIs in our study, Southern Private

University has only a few grant-funded programs that serve URM students, including one of the

oldest Ronald E. McNair programs in the country, the College Assistant Migrant Program

(CAMP), and NSF-funded Living Learning Communities (LLCs).

**Coding and Analysis**

Broadly, site visits, coding, and analysis occurred simultaneously to facilitate ongoing

reflection of the data by multiple team members. During site visits, the team concluded each day

of interviews with a meeting to discuss and reflect on salient themes. Analysis continued after

site visits were completed. Following each site visit, the team used memos, along with

webscraping data, and documents collected during the site visit to write an institutional report

that identified unique themes and themes within the context of each campus. These institutional

reports were constantly edited once transcripts were coded and were revisited by the research

team to achieve a deeper level of understanding of each institution's context.

The team used open-coding on each interview transcript by examining the raw data and

coding for salient categories (Corbin & Strauss, 2014). The "constant comparative method of

analysis" in grounded theory is commonly used across various qualitative research traditions,

including case studies (Glaser & Strauss, 1967). Using the constant comparative approach, we

revised and refined codes until the data did not yield further insight (Miles and Huberman,

1994). The team then developed axial codes by narrowing larger text segments to interconnected

themes and categories. After developing general categories of codes or themes, each of us,

working independently, used axial coding to group related categories or themes to make sense of

the data (Creswell, 1994). In some cases, this work resulted in assigning an overarching category

to several extant codes (e.g., reasons for explaining success at the institution includes the

following elements: with respect to the entire institution, faculty, or students). In other cases, it

meant developing sub-codes to capture nuances. Transcripts were thus coded based on the

codebook developed from the team after they went through the first few site visits. Some codes

were developed a priori. We ensured interrelater reliability at 85% for team members in coding.

To analyze themes for each campus, we analyzed the data collected from each institution

for emergent within-institution themes, with each campus being treated as a comprehensive case

in and of itself (Merriam, 2009). The purpose of this step was to determine if any organizational

strategies appeared to depend on unique aspects of the institutional context. Additionally, the

institutional reports for each institution were revisited and revised. We also created matrices to

track major STEM interventions and strategies at each institution.

To analyze themes across the 11 campuses, we conducted cross-case analysis, an analytic

technique that facilitates the comparison of commonalities and differences of multiple cases and

is used to synthesize the information gained from each individual case (Merriam, 2009; Yin,

2013). In cross-case analysis, the primary focus partially shifts away from the individual cases

and toward the *quintain* – the overarching collective cases or target phenomenon under study

(Stake, 2013). Applied to this study, the emergent themes at each campus began to answer our

research question, yet they did not fully address them until emergent themes were compared

across institutions. For example, one HSI may simply be more reflective of unique features or

idiosyncratic conditions. Yin (2017) describes the within-case patterns as "tentative conclusions"

(p. 196), and it is not until assertions are made at the cross-case level that the research questions

are fully answered (Stake, 2013). Our multi-institutional analysis allows for validation of the

findings across sites, and multiple interviews per campus allows for cross-validation of findings within institutions (Yin, 2013). We used matrices to visually display thematic codes across to facilitate the comparison of institutional contexts (Miles and Huberman, 1994).

To achieve the purpose of this study, the team looked for themes that were unique to HSIs, and further examined how each theme was displayed given the unique context of the HSI. Using a matrix, the team also compared themes that emerged and looked at all 11 institutions to compare HSIs with the contexts of the 11 institutions. Studying the quintain ensures that our study is focused on collective themes and divergent cases, comparing HSIs and then comparing HSIs with non-HSI cases. We constantly reviewed the institutional reports to examine themes at each institution as well as themes within the institutional context, and compared these themes across all institutions. At times, we went back to codes from the transcripts to make sure we were understanding context and level of organizational strategy implementation at the institution. We met several times over the course of 10 months to discuss general categories or themes and how they related to one another. When we differed about particular points, we reexamined the institutional report, matrix, or theme in question and discussed it until consensus was reached (Fraenkel & Wallen, 2003). We developed four themes unique to HSIs, which are discussed and explained in the next section.

## Results

### Institutional Comparisons

In this section, we summarize comparisons first across the HSIs and then across the 11 case studies to draw conclusions about expanding the evolving set of characteristics of HSIs and other institutions that have been efficient producers of URM STEM degrees.

**Heterogeneity across HSIs.** It is important to note that the variability across the HSIs

extended beyond size and Carnegie Classification, and also included when the HSI received

federal designation and the HSI's organizational identity. Table 1 illustrates that general

characteristics can inform the context and institutional identity. According to the Núñez et al.

(2016) typology, Southern Private is a *Small Communities Four-Year*, or Catholic institution as

many small HSIs are, which typically have the highest graduation rates among HSIs. Three of

the HSIs in the study can be categorized under Cluster 3: *Big Systems Four-Years*, which

encompasses institutions that typically belong to state public institution systems, but it is

important to note that each HSI in this study has established a unique identity in their campus

systems.

Table 1

*Distinguishing Hispanic-Serving Institutions in the Study*

| Institution Name (pseudonym) | Southeast State University | East Coast State University | West Coast State University | Southern Private University |
|---|---|---|---|---|
| Carnegie Class. | Public R1 HSI | Public R2  HSI | Public Master's HSI | Private Master's HSI |
| Undergraduate Enrollment | 41,038 | 8,170 | 22,157 | 4,620 |
| Latino enrollment % | 67.0 | 27.0 | 42.0 | 41.0 |
| Admittance Rate % | 50.0 | 65.0 | 39.0 | 77.0 |
| Year Institution Became an HSI | 2010 | 2014 | 2005 | 1990 |

| Geographic Location | Southeast | Northeast | West Coast | South |
|---|---|---|---|---|
| Institutional Diversity Typology (Núñez, et. al., 2016) | Big Systems Four-Year | Big Systems Four-Year | Big Systems Four-Year | Small Communities Four-Year |
| Organizational Identity (Garcia, 2018) | *Latinx-serving* | *Latinx-serving* | *Latinx-enhancing* | *Latinx-serving* |

Only one HSI is characterized as a Research 1 Institution by the Carnegie Classification, Southeast State University, which has a longstanding designation as an HSI and now has several Latinx Vice Presidents and Provost in its leadership team. As such, Southeast State University stands as an example of what a large public university can to do to be responsive to URM students' needs and also gain a national reputation in innovation in STEM. This includes the development of a STEM institute (grant-supported and then institutionalized) as an interdisciplinary hub for faculty, peer learning assistants, and scaling up pedagogical reform. Nonetheless, all the HSIs showed evidence of moving from lecture-based courses to more inquiry-based courses in STEM, and West Coast University was specifically known for its "learn by doing" approach to learning.

Based on Garcia's (2018) typology of organizational identities, three of the HSIs in this study are *Latinx-serving* (Southeast State University, East Coast State University, and Southern Private University), while one is *Latinx-enhancing* (West Coast University). All four of the HSIs in this study uphold an organizational culture that supports and enhances Latinx students' experiences on campus. Furthermore, while all the HSIs in this study are 'exemplary' institutions, (since they produce better-than-expected outcomes compared to similarly resourced institutions), three of the four HSIs have higher six-year graduation rates for Latinx students than

for white students, an indicator of equitable outcomes that distinguishes *Latinx-serving* HSIs. West Coast was still working on achieving equitable outcomes, although its efficient output for Latinx STEM degrees was much higher than other institutions in its system. This indicates that there is much work to be done in terms of achieving equitable outcomes at many institutions that offer access as *Latinx-enrolling* but have yet to become truly *Latinx-serving institutions*.

## Unique Characteristics of HSI STEM Institutions

This section examines the organizational strategies and practices that the four 'exemplary' HSIs in our case study use to foster achievement among students aspiring to attain STEM degrees. We organize the findings into four themes characteristic of HSIs that produce URM STEM graduates at efficient rates: (1) Knowing and Serving Students Well, (2) Being Receptive to Learning and Improving, (3) Hiring Diverse Faculty who Care About Teaching, and (4) Outreach & Service to the Surrounding Community. The first theme is composed of 3 sub-themes: (1a) Meeting students where they are academically, (1b) Understanding students and their backgrounds through an anti-deficit lens, and (1c) upholding a "high-touch" culture. At times, we discuss how each HSI's institutional context uniquely shapes how it enacts each organizational strategy, as well as the degree to which the theme was present at the other seven 'exemplary' non-HSI institutions to provide a comparison of how salient the theme is to an HSI's approach.

### Knowing and Serving Students Well

This theme reflects the way faculty, staff, and administrators know their students' backgrounds, challenges, barriers, and other critical aspects of their identities that impact their interest, experience and retention in STEM. Knowing students well is broken down into three sub-themes which involve mindset, understanding students and their backgrounds through an

anti-deficit mindset; action, meeting students where they are academically by providing

interventions to support learning and remove barriers to persisting in STEM; and creating a

student-centered environment, promoting a "high-touch" culture across departments at the

institution.

   **Meeting students where they are academically.** A common thread across all four

HSIs was the institutions' commitment to meeting students where they are academically. All four

HSIs provided some type of enrichment service to help support students who came to the

university academically underprepared or who needed help progressing in a coursework. For

example, West Coast State University offers a summer math preparation course, Early Start, for

incoming first-year students. Students who successfully complete the course are then able to

enroll in the first-year math series in the Fall along with the rest of their peers, which prevents

these students from falling behind.

  Meeting students also meant that faculty were willing to tailor their teaching efforts. For

example, a chemistry professor at West Coast State University described his efforts to help

students who were a bit behind the curve in terms of requisite prior knowledge:

> *I noticed that there are intro labs where you have uneven performance. Some students*
>
> *come in with advanced skills because their high schools prepared them well, while others*
>
> *don't have the background for me to jump right in. So I got a grant to videotape me doing*
>
> *the introductions to all the labs so they could watch it online and then come prepared to*
>
> *class.*

These introduction videos were later used by all the introductory Chemistry courses in the department. Finding ways to level the playing field in key courses decreased drop rates in introductory chemistry courses and increased retention in the major.

Similarly, at Southeast University, math faculty decided to restructure the Algebra 1 series since many students were not passing the lower division entry courses. Under the direction of the math coordinator, the number of college algebra sections available for a single class was reduced from 36 to 9 and the number of instructors teaching those courses from 20 to 5. Streamlining the lower division courses in the math department allowed learning objectives, grading structures, and pedagogical practices to be consistent from one course to the next. Moreover, the five instructors (discipline-based educators) teaching the nine sections were selected for their content expertise and experience working with students. As a result of these changes, students' pass rates improved tremendously.

Moreover, faculty met their students by connecting them to resources that would enhance their experience and strengthen their academic preparation. The majority of faculty at the HSIs received NSF, NIH, and HHMI grants, as well as other sources of funding, that allowed them to involve students in their research projects through paid summer and year-round research assistantships and enhance students' learning by making technological resources readily available to them. Faculty also connected students to resources on campus, whether it be to the Math Lab at Southern Private University or the Writing Center at East Coast State University, in order to ensure their academic success and development. Another faculty at East Coast State University began to offer informational workshops about how to successfully apply to a job because he found that many of his graduates had a hard time; he also connected graduates to his current students as a way to facilitate student networking.

**Understanding students and their backgrounds through an anti-deficit lens.** Faculty at all four HSIs were aware of the challenges their students faced as a result of taking time to develop relationships with their students and getting to know them on a personal level. For example, at East Coast State University one math faculty expressed giving students the benefit of the doubt when they did not come to class or turned in an assignment late. Instead of jumping to negative conclusions about students' work-ethic and marking them down, this faculty reached out to students directly. By doing so, the faculty member learned about the challenges and unique circumstances his students were facing, which were preventing them from fully engaging in his class. In response, the faculty granted students extended deadlines, provided them with on-campus resources, and offered his moral support.

It was clear that several faculty and administrators at the HSIs were familiar with their students' backgrounds and needs. Many faculty described students as being immigrants, first-generation college students, underrepresented racial minorities, community college transfers, children of migrant farmworkers, or part-time to full-time workers. Faculty said they learned to recognize their students' strengths as a result of the time they spent interacting with students, their families, and their communities. At West Coast State University, many faculty decided to live in nearby Latinx communities in order to fully immerse themselves in their students' environment. Other faculty, such as those at Southeast State University, were Latinx themselves (44.9%) and were driven by a commitment to serve Latinx students.

As faculty got to know students on a personal level, they grew to admire students' work-ethic and perseverance. Faculty and staff at Southeast State University were acutely aware of the challenges their students encountered, like having to work more than 20 hours a week, being the first in their families to go to college, taking care of a family member, or a reluctance to leave

family for opportunities like internships or research. These faculty expressed admiration over their students' work ethic and hunger for knowledge. As a result, faculty were motivated to work long hours for no additional pay because they recognized the difference it would make in students' lives and they had witnessed students' immense gratitude. Faculty admiration for students was also prevalent at Southern Private University, where nearly all the faculty we spoke with were aware of their students' participation in the College Assistant Migrant Program (CAMP), a program that provides financial, academic and moral support to students of migrant farmworkers. Faculty spoke very highly of CAMP students, praising their ability to perform well in their courses, despite having external familial obligations that kept them busy year-round. Similarly, East Coast faculty and staff also noted an awareness of the struggles associated with their urban and low-income status students (53% are Pell-eligible), including the need to work and get a degree that promised social mobility. Moreover, at Southeast State University and West Coast State University, faculty pointed out that many of their students were highly motivated because they were the first in their family to go to college. For example, a chemistry faculty at West Coast State University connected with her first-generation students because she was also the first in her family to go to college. She was aware of all the challenges (i.e. structural, emotional, psychological) that came with being a first-generation student and was committed to supporting and affirming her students.

In addition to knowing the challenges students' encountered and admiring their perseverance, faculty demonstrated an anti-deficit lens through which they viewed students and their ability to succeed. A math faculty member at Southeast State University expressed the common sentiment well:

*Well, my perspective is that -- and it's the same way for all of the other learning*

*assistants as well as the director of the program. No one is born a winner, right?*

*Everyone is born with the same ability to understand math and learn it. Of course some*

*will take more time than others based on whatever misconceptions they had before,*

*whatever environment they probably study in and all of that. Well, we all believe and I*

*always share that with my students, "I believe every one of you could do well in this*

*course." And I always tell that at the start of every semester. So, talent, I always believe*

*the talent is there. So, it's just [knowing how to] kind of harness that talent, help them*

*harness it as well.*

**Promoting a "high-touch" culture.** All four HSIs described having a student-centered

approach that was reflected through faculty, staff, and administrators' initiative in reaching out to

students, monitoring their progress, and creating structures to support them.

At all four HSIs, faculty discussed monitoring students' progress and reaching out to

students who were falling behind or were withdrawn in the course, either through a text message

or through a phone call. One faculty member from the physics department at Southeast State

University explained how he learned over time to check in with students because they may be

struggling but are not always aware of the reason. He explained the importance of faculty being

able to intervene in simple ways, *"But sometimes just someone who says, hey, you know, I can*

*see you're not operating at the level that you ought to be, you know, you've got the smarts, but*

*there is something in the way, what's going on?"* The faculty explained how providing an extra

connective experience makes a difference in students' morale, performance and learning.

Advisors also upheld a "high touch" culture across the HSIs. At Southeast State

University, a significant number of academic advisors were being hired each year to achieve the

300:1 advisor-to-student ratio that defines 'best practice' nationally. As outlined on their

advising webpage, part of their Graduate Success Initiative (an extensive, university-wide set of

innovations dedicated to helping undergraduates succeed academically) includes "reaching out to

students proactively with guidance and not waiting for them to contact us;" the institution boasts

that the GSI initiative is not only high tech, but it is also "high touch." Similarly, advisors at

Southern Private University were described by an administrator as "free-range chickens," who

are encouraged to reach out to students instead of waiting for students to visit their office. The

summer before students begin their first semester at Southern Private University, advisors reach

out to students via phone or email to introduce themselves and establish rapport so that students

feel supported even before they step onto campus. Thus, despite institutional size, campuses

employed an intrusive advising approach.

Staff and faculty relationships with students were particularly surprising at larger

institutions like West Coast State University and Southeast State University, which have student

populations of 22,157 and 41,038 students respectively. With a class of 120 students, a faculty

member in the biological sciences department at West Coast State University described the

importance of faculty as leaders in showing their care and passion no matter the enrollment

numbers in a course:

> *In my ability, I had taken large classes like that and made it an informative experience...I*
>
> *had them develop study groups and meet others and be part of something within the class*
>
> *and outside the class...part of it is just be more intentional about stepping through these*
>
> *things and providing ways by which you can develop a good study habit or you could go*
>
> *about studying for an exam, offering them suggestions. We do a lot of reflective work in*
>
> *class okay...It's all a balance, but the faculty member in that context plays a pivotal role*

*in that [students] are either going to come with you, they are going to trust you...And so,*

*the approaches that are taken there, the care, the passion that is exhibited by the*

*leadership in that class is important.*

A biology professor at Southeast State University described the way she works with

students as "modified mentorship," through which she seeks to have a personal relationship with

all students in her classes, even when she has 40 students in one class. She described one of her

strategies saying, *"This seems trivial, but it's not. I try to know their names. I try to pronounce*

*their names correctly. That to me, is hugely important. It's human recognition."* She went onto

describe how making the effort to do something as small as knowing students' names helped

create an environment in which her students felt comfortable asking questions, sharing ideas, and

expressing themselves. Once this initial rapport was established in class, students were more

willing to visit her during office hours to discuss both academic and personal matters. The

professor described how one student opened up to her about a family issue that was making it

difficult for her to fully concentrate in class. The professor referred the student to Southeast State

University's counseling center and scheduled meetings to check in with the student on a weekly

basis. By the end of the term, the student received a high grade in the course. The student visited

the professor's office at the end of the term and thanked her, nearly in tears, for her invaluable

support.

At West Coast State University faculty described their high touch efforts as "intrusive

community building" in classes to get students to talk to one another. This practice was

particularly important because West Coast State University is a commuter campus, where the

majority of students commute rather than live on campus and 40% of undergraduates are transfer

students. One faculty from the biological science department equated her high touch academic mentoring role to that of an "academic mother":

> *What I say to them, I say I'm your academic mother. So I'm always going to be involved with you. Like it or not I am always going to be your academic mother. And evidence of that is that my senior scientist is one of my former students. The guy that I collaborate with, with this other company that I work with, he's one of my former students. I do lots of collaborations with my former students. I try to help them emotionally when needed, I'm there to be their colleague, and I'm there to be their guide when they need that. And when they mature and they become independent scientists they become my colleague.*

A faculty from the agriculture department at East Coast State University also equated the high touch culture of the HSI to that of a family, where students are viewed as faculty's own kids:

> *They care about you as a student, as a person who is also a student. I've had teachers tell me that they've bought books for students. I often see people put themselves out for students—I think that's everyone here, in general, for the most part.. The students here, you treat them like your kids.*

The notion that students are like "your kids" and faculty are like "academic mothers" conveys the root of these HSI's high-touch culture: an ethic of care, whereby staff, faculty and administrators are invested in students, assume responsibility for students' outcomes and genuinely want to see their students thrive.

**Knowing and Serving Students Well at Non-HSIs**

While knowing and serving students well was a salient theme among the HSIs, aspects of this theme (and its corresponding sub-themes) were also present to some degree in the other

seven institutions in our sample. For example, faculty at the two campuses with relatively large

Native American enrollments in our study also expressed a belief that their students were capable

of succeeding in their intended majors, and put the onus on themselves as educators to ensure

they were supporting their students' academic success.

Faculty at Central Plains State University acknowledged the reality of their institution

serving the state and not serving as an elite, gate-keeping institution. They expressed a

commitment to educating the students they have without lowering standards, while also

recognizing, as one faculty member put it, that "we are not MIT." Indeed, there was an overall

culture of taking pride in helping students and employers of the state by preparing students for

jobs upon graduation. While faculty at the HSIs mentioned their large shares of Latinx students

and the ways students' racial/ethnic identities influenced the institution's culture,  Central Plain's

culture was largely influenced by the relatively large proportion of students who identified as

Native American. Faculty were concerned that they were not doing enough to support their

Native American students and expressed a desire to do more. Several interviewees mentioned

Central Plain's culture of humility, suggesting that the main reason the institution does so well in

cultivating STEM undergraduate degrees is because many key supporters simply do the work

needed to support students without advertising or thinking of their efforts as "strategic."

Furthermore, similar to faculty at the HSIs,  faculty at Central Plain often credited their students

with possessing talent and an ethic of hard work, rather than crediting themselves for

contributing to students' persistence in STEM majors.

These cases recognition of their role in promoting students' success was captured by one

of these institution's maxims: "Make mathematics a pump and not a filter in the pipeline to

careers and success." This sentiment was observed in mathematics resources offered to students

at this institution. For example, a math faculty at Central Plains discussed an important program that developed students' mathematics abilities: "Not too long ago the Math Department developed the Success in Undergraduate Mathematics (SUMS) Program, which aims  to attract and retain STEM undergraduates by improving student retention and success in calculus and entry-level courses. It's really a great effort that's been pivotal." The faculty went on to explain how SUMS provides innovative resources and practices for student learning and success in mathematics courses, such as: implementing a mandatory and enforced Placement Exam for first-time enrollees in a mathematics class; enhancing support and training for academic advisors; providing dedicated coordination and supervision of entry-level mathematics; adding Clinical Faculty Fellows to provide best-practice pedagogy to introductory STEM courses; providing training for Teaching Assistants and Instructors; and curriculum revision to incorporate concepts, problem solving, and inquiry-based learning.

Another practice that demonstrated institution's commitment to serving its students was observed at Northern Mountain, which created and appointed an Associate Vice President for Diversity and Equity to advance initiatives focused on enhancing the academic and social support of URM students and faculty. Initiatives comprised the inclusion of a global and diversity requirement in the undergraduate curriculum, the development of cultural and ethnically focused student clubs and organizations, and the creation and implementation of diversity focused programming such as the Native American Convocation, the Hispanic Convocation, and the Women of Color Conference.

Moreover, at one of the PWIs in our sample, an anti-deficit mindset was also observed. However, it was mainly present in the School of Nursing rather than across departments or broadly throughout the institution, as was characteristic of the HSIs. Students, faculty, and staff

in the School of Nursing at the University of the Southeast relied on the Director of Diversity to make sure conflict was handled productively, that the curriculum was infused with diversity, and that minority identity groups felt safe and supported. Prescribing the role of Director of Diversity to one individual rather than promoting an institutional culture that promotes knowing and serving diverse students well in STEM fields distinguished the University of the Southeast from the HSIs.

**Institutional Receptivity to Learning and Constantly Improving**

Another salient theme among the HSIs was their receptivity to learning and constantly improving their practices by adopting "best practices," hiring experts in a specific discipline, and being open to innovating and transforming their classrooms. Their amenable attitude positioned them well to adapt to students' changing needs and incorporate nationally recognized practices into their STEM departments.

At Southeast State University campus administrative leadership were constantly seeking partnerships and learning from the successful practices of other institutions to substantially increase their number of STEM graduates. For example, the executive Vice President of Academic Affairs discussed his strong ties with the Science Math Teaching Imperative (SMTI), a group of STEM institutions that work together and meet to talk about the function and purposes of an educationally-focused STEM campus, how to provide resources to faculty and increase their engagement, and what works best in STEM teaching and learning. The Executive Vice President of Academic Affairs explained:

> *We are part of the Science Math Teaching Imperative or called SMTI or S-M-T-I, it's part*
>
> *of the Association of Public and Land-grant Universities. And we're one of the founding*

*SMTI universities. And what that required was that the president and the provost*

*committed to substantially increasing the number of graduates in STEM areas,*

*particularly developing STEM teachers, math and science teachers in particular. And so,*

*that was sort of the beginning of kind of getting the departments on board with things like*

*the [peer] learning assistance program, starting with physics, and that was across a lot*

*of the disciplines.*

In addition to improving their practices through participation in STEM organizations, the HSIs were also adopting innovative practices that proved successful at other universities across the U.S. A faculty in the biological sciences department expressed Southern Private University's propensity to learn saying, *"a lotta the innovations have been things that have been happening nationally."* For example, Southern Private University hired a Process Oriented Guided Inquiry Learning (POGIL) expert to redesign all its lower division classes in the chemistry department because POGIL was a proven "best practice" implemented widely at other colleges. The math department at Southern Private University also implemented the Assessment and Learning in Knowledge Spaces (ALEKS) software, an online assessment tool designed to help students determine what material they know and what concepts they need to review in mathematics. Faculty cited studies on math placement where students whose placement was border-line were allowed into the higher-level math classes and were able to succeed, as grounds for implementing ALEKS into their math classes.

A math faculty at Southeast State University also discussed drawing on a STEM teaching program's model that had proven successful at the University of Texas, at Austin, "*this science and math teacher program is imperative, [Southeast State University] Teach, so you know the You Teach Program out of UT Austin, we have a replication here of that. And it's proven highly*

*successful."* In addition to contributing to the design of the [Southeast State University] Teach

program, this faculty was committed to staying informed about the best research-based practices,

he described his efforts, "*So I have been reading research papers, education research. A lot of it

has been just conversations with Leanne Wells, she's a primary person that is trying to really

change the landscape of undergraduate math and developmental math, too. So that's where I

draw from personally."*

Similarly, at West Coast State University administrators discussed implementing Science

Educational Enhancement Services (SEES) based on the University of California, Berkeley's

Treisman's model, which found that integrating rather than separating students' academic and

social lives leads to increased performance in introductory math, chemistry, and physics classes.

The purpose of the Science Educational Enhancement Services (SEES) program is to increase

the retention and graduation rates for Latinx, African American, and Native American students

pursuing degrees in the sciences and mathematics. As a result of implementing SEES, West

Coast State University witnessed increased performance among first year students in STEM

classes, nearly 50% earned an B or higher. URM students who participated in SEES also had a

persistence rate that was 15% higher than those who didn't take part in SEES.

Being receptive to learning and constantly improving in relation to the characteristics of

the student body was a theme particularly noteworthy at the HSIs in the sample. The PWIs did

not seem to express the same disposition, speaking in terms of challenges with embracing change

for a more diverse student body. For example, one of the PWIs in our sample, University of the

Southeast, mentioned that in previous years, students protested to have one of the dorms renamed

from the name of a slave owner to the name of an African American leader. The board of regents

approved the change, but created a memorandum so that no buildings could be renamed for 16

years. Even after student opposition, University of the Southeast continues to hold onto relics

and symbols which some faculty associated with the racist history of the South. For example,

there are several campus buildings named after confederate soldiers and deceased members of

the KKK. There is a statue commemorating a fallen confederate soldier proudly displayed in the

center of the campus. The refusal to make even this change underlies larger issues with the

institution's wavering commitment to serving diverse students.

**Hiring Diverse Faculty and Those Who Care About Teaching**

Faculty and administrators conveyed the importance of hiring a diverse group of faculty

to reflect the increasingly diverse student body. They observed that Students of Color were more

willing to approach diverse STEM faculty, which allowed for  mentoring relationships to form

and the possibility for faculty-student research opportunities. Three of the HSIs (West Coast

State University, Southeast State University, and Southern Private University) have valued and

put in efforts to hire diverse faculty in STEM for several years, with the diversity of their faculty

almost mirroring that of the students and how they hire with an eye toward individuals who have

experience working with underrepresented groups:

> *If you're a faculty member in Southeast State University you have extensive experience*
>
> *working with underrepresented minorities because that's our student body.  And I would*
>
> *say – I don't know if it's the majority but certainly approaching a majority of our faculty*
>
> *members are themselves very diverse in terms of their ethnicity or race.  And then we*
>
> *have African Americans, Indians, Hispanics, Asians, I mean our faculty is probably*
>
> *almost as diverse as our student body but not quite.*

The chancellor at East Coast State University was relatively new in her position at the time of

our site visit, but her prioritization of  hiring diverse faculty in STEM departments had begun to

make an impact on changing departmental values about faculty diversity. As one faculty member

in the biological sciences pointed out:

> *My personal experience, again, this is probably just my department, but my personal*
>
> *experience was that not everybody saw the value in [hiring diverse faculty], like other*
>
> *faculty. I mean, maybe that's always gonna be the way...—there's always gonna be some*
>
> *people that say, 'It doesn't really matter. Just pick the best person.' Certainly I feel like,*
>
> *especially with our new Chancellor, that message [of hiring diverse faculty] is being*
>
> *repeated a lot. Eventually, it's going to sink in... We're hiring a couple people right now.*
>
> *The hiring committee that I was on this time took it very seriously....I think that's what*
>
> *the top-down message is, is that we need to do that. It's important and valued.*

While all campuses shared that they placed value on hiring people that care about

teaching, the HSIs placed a high emphasis on hiring diverse faculty who can teach, who look like

the students, and who displayed a passion for the diverse student body. Only one campus with a

significant Native American population, Northern Mountain University, was similar to the HSIs

in this regard. Northern Mountain made strong efforts to recruit and retain faculty of color,

particularly Native American faculty in an effort to reflect the campus' changing racial, ethnic,

and gender demographics.

The two HBCUs in the study also reflected a desire to hire faculty that care about campus

population. Mid-Atlantic University stated that the faculty members don't necessarily need to

look like the student population. Instead, hiring committees placed emphasis on looking for

faculty that are committed to serving minorities, care about teaching, and possess an anti-deficit

approach to teaching students. A STEM administrator at Atlantic Southern State University

emphasized the importance of hiring faculty who also are committed specifically to undergraduate teaching and training:

> *So we are looking for faculty who are committed to the type of institution that we are. So we are a historically black institution, we serve lots of ethnic minority and first generation students. And so understanding that and the opportunities and challenges that come with that kind of a population are very important if you are going to teach in an institution like this. We're also interested in [faculty]who understand, especially the majority of our STEM programs, they're undergraduate programs.*

Similarly to Atlantic Southern State University's culture of hiring faculty who understand and are committed to the institution's student body and mission, Southern Private University created a master teacher category for promotion and tenure in order to improve student success outcomes and attract faculty who would be interested in the role's emphasis on teaching. The Associate Dean stated, "*they can actually do what they love, which is focusing on students. What you have in departments then is you have people being hired in whose primary focus is on student success, student learning, and teaching, and they serve a very vital role in the department.*"

In somewhat of a contrast to the prioritization of diverse faculty hiring, at one of the PWI institutions, University of the Southeast, a STEM program administrator shared that although the number of women faculty in STEM departments was steadily increasing over the past decade, she noted the financial challenges of hiring racially diverse faculty at her institution:

> *...our salaries are not as high as some other places and if someone's a hot faculty member of color or recent graduate of color, it's hard to compete with other places that are offering them better startup packages or higher salaries. So that's been a real issue and we have to find ways to start to address that.*

This indicates that PWIs, especially the research intensive ones, continue to compete for a "small" pool of candidates for the traits they seek, even though the availability pools are much larger in the disciplines and scholars contend that bidding wars are overstated (Trower & Chait, 2002; Smith, Wolf, & Busenberg, 1996). These insights suggests a need to identify better ways to identify and develop racially/ethnically diverse candidates who have a love for teaching and do research at their institution. This institution began to hire fixed term, full-time teaching specialists for specific disciplines with external grant support and central administrative support.

**Outreach & Service to the Surrounding Community**

Faculty, administrators, and program directors at all four HSIs attributed their success in graduating higher-than-expected rates of STEM bachelor's degree holders to their K-14 outreach efforts and service to the local community. Three of the four HSIs are located in large, diverse cities, and several interviewees noted that it was part of the institution's mission to know the community, engage with the community, and serve the community. One senior administrator at East Coast State University said:

> *We consider ourselves...not being solely in (city), but of (city). That means that our linkages and our partners, and when we're thinking about building educational experiences, we're not solely thinking about building them for our graduate or undergraduate students. We're also looking at enhancing a pipeline of students and opportunities.*

The administrator underscored East Coast State's larger mission of supporting the education of underserved communities, not simply setting up programs to get to STEM. East Coast State also had significant relationships with pharmaceutical companies in the region for creating student placements and educating professionals.

Outreach programs ranged from day-long science days for elementary and middle school students, research intensive summer programs for high school students, developing dual enrollment courses for the institution and the local high schools, and intentional collaboration with local community colleges to improve the alignment of STEM curriculum from the community college to the HSI. While most of the institutions in the study invested campus resources into community partnerships with high schools and community colleges, HSIs were unique in emphasizing the importance of every individual they can impact with such programs. One senior administrator in the Physical and Biological Science departments at West Coast State University emphasized that every student counts, thus partnerships with the community are extremely important:

> *So, we have great success with Hispanic students, for example, but also with African-American students...So, for example, we've just established a collaboration with East LA Community College. And they're particularly interested in CS and Physics transfers. Again, it's not huge but, you know, every, every single person makes a difference [in fields where they are highly underrepresented]. And so, we, we should be—we'll be looking forward to that. So, we sort of reached out to the school districts that we're in. We reached out to community colleges that are nearby and are interested in collaborating with us and that allows us to be efficient[in student pathways].*

Interestingly, the two campuses with high Native American populations were the only other institutions that also shared this theme of valuing every individual they can provide access to resources and/or retain in the STEM pipeline. A few of the institutions, either through their own initiative or as required by grant funding, constantly assessed the impact of these programs and found amazing success in STEM major retention for their students. One faculty member and

well-known change agent in the Environmental Science department at East Coast State
University took great pride in the drastic increase of underrepresented racial minorities who now
major in geology compared to the national average:

> *We ran a summer program where I laddered it up ...you gotta ladder it up on a nice*
> *pathway from the kids to the next step, to the next step, so they see that there's a pathway*
> *for them to go on. I had a grant also from NSF—and I ran it for seven years. We had an*
> *afterschool program. We did this thing called Dinosaur Day over at the [city] Museum.*
> *We got the whole culture changed to look at this stuff better. Our numbers and Geology*
> *went through the roof and...we have 54 percent of our undergraduates are*
> *underrepresented minority students. You know what the rest of the country is? Nine*
> *percent.*

Often, results from these initiatives were used to justify the importance of such a program to
increasing campus diversity and overall success in promoting STEM degrees.

**Comparisons across institutions**. In the following section we will highlight key shared
practices found across all 11 institutions but also featured prominently at HSIs; these include: the
use of undergraduate learning assistants and innovation occurring in mathematics. It is important
to note that the HSIs employed a host of practices that had often been proven elsewhere, adopted,
and adapted for their students. We do not include practices that are prominent among institutions
nationwide, such as undergraduate research, which is a proven and evidence-based practice.

*Undergraduate learning assistants.* Several institutions utilized undergraduate students
in STEM courses to both develop the talent and skillset of selected student leaders, and to
increase learning gains for students in the course. Titles and roles ranged from undergraduate
teaching assistants who assist with course instruction, to peer liaisons who plan events for majors

in a specific STEM department. Indeed, the majority of institutions in our sample relied on

undergraduate students to serve as teaching assistants, however Western Private College

leveraged this aspect of their student enrollment and developed a multi-*level peer to peer support*

*system* coordinated by academic departments, student support services, and the Dean of

Students' Office. Departments instituted a peer-to-peer support system that most STEM

departments (with variation) have designated as *Liaisons, Teaching Assistants (TAs), mentors,*

*and fellows*, with differing job responsibilities, though all roles aimed to support student success.

Among all institutions, Southeast State University served as a model for its use of

learning assistants to improve learning outcomes. The learning assistant (LA) program started in

2008 in physics and spread into other science departments and mathematics. Once partnered up

with faculty teaching gateway courses, LAs meet with faculty weekly to plan engaging class

exercises and to identify difficulties students are having in the course. The implementation of

LAs in gateway courses has impressively improved pass rates in math and physics. Similarly, at

West Coast State University, one faculty member in the biological and physical sciences

highlighted their use of learning assistants as new model that "efficiently" used minimal

resources to improve outcomes:

> *Other reasons for efficiency, I think, are newish models.  For example, our use of*
>
> *learning assistants.  I don't know if you've heard about that but it is undergraduates who,*
>
> *senior or junior undergraduates, started off in Physics.  In fact, it was a PKAL*
>
> *initiative....that's now spread to biology and is spreading to geology.  So, we're spreading*
>
> *some efficient practices.  So, in for example, a larger lecture, there would be either*
>
> *breakouts or availability of these allies, peers essentially to say, "This is how you succeed*
>
> *in this class."  So, that's an efficient use of resources.*

The University of the Southeast also incorporated undergraduate learning assistants into their redesigned introductory STEM courses, which were reworked to incorporate active learning into the curriculum. Faculty worked with graduate assistants and undergraduate peer helpers (who received training on how to teach and on metacognition) to facilitate class learning.

***Mathematics-specific innovation.*** It is important to note that all exemplars were engaged in some innovation in specific STEM departments, though there was less emphasis on mathematics compared to the HSIs in terms of student preparation and reform. This may well be because the access is much greater at HSIs, and therefore preparation and enrichment coursework was still a necessary part of the college curriculum.  For example, the math department at Southern Private University implemented several successful practices, from flipped classrooms to online placement tools and research sequence courses. The math department provides a research sequence for math majors that fosters a supportive community in which students go through the learning process together and can help one another. The departments also had a tenure-track course coordinator for gateway classes,  who ensures uniformity of experience across different math sections. Knowing that math is often a stumbling block that STEM students encounter, Southern Private University established a math lab ten years ago, and it is now one of the most effective resources students have. Southeast State University also had a math equipped with math learning software installed on computers in the lab so that students could practice math problems on campus and can get immediate help from trained LA's or TA's who staffed the lab. The math department at Southeast State University was especially interested in helping students pass gateway math courses and decreasing the number of students who dropped these courses. Change started when one instructor convinced other math instructors that math was crucial since students who did not pass math would not be

able to pursue a STEM major. The department implemented several changes to transform the lower division math courses and pass rates improved tremendously.

Similar to the HSIs in its organizational culture focused on serving its students, both the practices and process of transformation in mathematics at Central Plains State University mirrored events at Southeast State University. In an effort to decrease D/Fail/Withdraw (DFW) rates, the mathematics department adapted a model where all introductory math courses are taught by clinical instructors with math education backgrounds. The overall intervention and uniformity of courses made a big difference by leading to a decrease in failure rates for these courses. Central Plains State University also had a similar resource on campus designed to integrate tutoring, peer learning, and math course office hours in one physical location on campus.

In terms of mathematics preparation for incoming students, three out of the four HSIs use ALEKS, an online technology that not only assesses student knowledge for course placement, but also helps students identify areas to focus on and provides learning modules to get up to speed. Two non-HSIs, Central Plains State and Mid-Atlantic University, also employed ALEKS for math placement, while Midwest State University used a home-grown version that mirrors ALEKS for both mathematics and chemistry.

It is important to note that math is a prerequisite for many majors in STEM, and a quarter of all entering college students report that they need additional assistance in this area (Eagan et al., 2014). Therefore, many more campuses could stand to improve mathematics teaching and learning.

**Conclusion and Lessons Learned**

Many institutions are faced with trading "efficiency" in degree production for their

commitment to access, often with negative consequences for growing racial/ethnic populations in

the regions they serve. By identifying "efficient" producers and contributors to STEM degree

attainment nationally, and then comparing HSIs among this group, we have found institutions

that repudiate this tradeoff using campus strategies and principles that guide educational support

for students that will become part of the diverse scientific workforce. In essence, the institutional

efforts indicate a belief that the success of their students *is* the success of the institution.

This study shows variability within the HSI category, similarities across them, and the

distinctions between HSIs and other institutions that serve URM students. Two HSI typologies

helped identify variability across the HSIs in this study (Garcia, 2018; Núñez et al., 2016),

indicating distinct contexts and variation in achieving equitable outcomes for Latinx students.

We extend characteristics that distinguished HSIs from other STEM exemplar institutions. First,

we confirm the findings of earlier organizational identity work that characterized an HSI as (1)

regionally focused, (2) committed to the community, (3) dedicated to access, and (4) serving a

diverse population (Garcia, 2013). These were similar commitments across the HSIs in this

study. For example, community connections not only ensured a pathway and better preparation

of STEM students entering the four-year colleges but also such connections were developed by

college presidents with employers in the region that would result in jobs for graduates.

We also extend these organizational traits by indicating the unique ways that HSI STEM

exemplars carry out their commitments:  By knowing and serving students well, including

meeting students where they are academically, employing "high touch" activities, and using an

anti-deficit lens. It is important to note that PWIs that served large Native American enrollments

also employed a student-centered and culturally-responsive approach because of their unique

population. Students report that HBCU faculty typically employ a talent development approach to take them to the next level of achievement (Hurtado, Eagan, Tran, Newman, Chang & Velasco, 2011),  whereas the HSI faculty interviews indicated that they share similar characteristics regarding student-centered practices. What is remarkable is that the HSIs in this study are able to achieve this despite their size, and this is related to another principle in that the institutions are seeking and hiring faculty that are diverse and, most importantly, are focused on teaching in their disciplines. It was inspiring to hear faculty talk about their strategies and connection with students. Finally, a related approach is institutional willingness to learn and flexibility to engage in STEM innovations, adopting evidence-based practices proven at other institutions, and gaining a reputation for success. Other STEM exemplars are also innovating but it can often be concentrated in specific disciplines. All these lessons can be readily adopted on many other campuses, but the commitment to student success is palpable on these HSI campuses and largely dependent on strong faculty commitment with leadership support. These two basic elements were also critical on several other campuses in the study for promoting institutional change.

By uncovering the unique and shared organizational practices that exemplary HSI campuses engaged in within classroom and extracurricular academic contexts to develop the talent of their diverse students, this paper helps to indicate what is possible even in the face of resource constraints. This should serve as encouragement for institutional agents to organize their STEM learning environments to improve student success and ultimately bolster STEM degree attainment. As more campuses achieve HSI status (over 400 are now emerging HSIs), the lessons learned here should encourage institutional leaders to seek strategies to further define their institutional identity as HSIs and as producers of STEM degrees. This may also result in

funding opportunities to achieve these goals through Title V grants, and NSF now offers a new

funding initiative specifically for these institutions. Other funding organizations continue to

reward good ideas that will leverage talent in the growing Latinx population. Because HSIs are

educating a large number of URM students, they play an important role in attracting and

developing the talent of students aspiring to pursue STEM degrees and represent important

vehicles to diversify and expand the STEM workforce (Harmon, 2012). Considering the

important role that HSIs play in graduating Latinx students in STEM, HSIs represent important

contexts of further inquiry from which other institutions can learn.

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Appendix

Table A1

*Chart of Institutions in Study*

| Institution Pseudonym | Control | MSI status | Classification | Efficiency Scores |
|---|---|---|---|---|
| University of the Southeast | Public | N/A | Doctoral Universities: Highest Research Activity | .79 All STEM |
| Atlantic Southern State University | Public | HBCU | Master's Colleges & Universities: Medium Programs | .89 American Indian .84 Black .52 Latinx |
| Southeast State University | Public | HSI | Doctoral Universities: Highest Research Activity | .82 Latinx .53 Black .35 American Indian |
| Northern Mountain University | Public | N/A ** | Doctoral Universities: Higher Research Activity | .94 American Indian .75 Latinx .25 Black |
| West Coast State University | Public | HSI | Master's Colleges & Universities: Larger Programs | .83 Latinx .37 American Indian .27 Black |
| Western Private College | Private | N/A | Baccalaureate Colleges: Arts & Sciences Focus | .73 All STEM |
| East Coast State University | Public | HSI | Doctoral Universities: Higher Research Activity | .81 All STEM |

| | | | | |
|---|---|---|---|---|
| Mid-Atlantic University | Private | HBCU | Doctoral Universities: Higher Research Activity | .76 Black<br>.40 Latinx<br>.35 American Indian |
| Central Plains State University | Public | N/A** | Doctoral Universities: Higher Research Activity | .96 American Indian<br>.44 Latinx<br>.35 Black |
| Southern Private University | Private | HSI | Master's Colleges & Universities: Larger Programs | .65 Latinx<br>.35 American Indian<br>.12 Black |
| Midwest State University | Public | N/A | Doctoral Universities: Highest Research Activity | .75 All STEM |

**High population of Native American students