Faculty and Administrators' Servingness in Engineering Education at Hispanic Serving Institutions: A Systematic Review

Dr. Hyun Kyoung Ro, University of North Texas

Dr. Hyun Kyoung (Hyunny) Ro, Associate Professor of Counseling and Higher Education at the University of North Texas, holds a Ph.D. in Higher Education from The Pennsylvania State University with a minor in Educational Psychology—Applied Measurement. Her research focuses on Gender and Racial Equity in STEM Education, Learning Experiences and Outcomes for Marginalized Students, and Critical Quantitative Research and Assessment.

Shirley Anderson, University of North Texas

Shirley Anderson is a Ph.D. student in Higher Education at the University of North Texas. She is also the Assistant Director of the Health Professions Advising Center at UT Dallas. Her research interests surround the topic of Marginalized Students in Healthcare.

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Abstract

This systematic review study aims to investigate the roles and contributions of engineering faculty members and administrators in enhancing the educational experiences of Latinx and other BIPOC students at Hispanic-Serving Institutions (HSIs). Recognizing the pivotal role of HSIs in attracting and retaining racially minoritized students in engineering programs, the study seeks to comprehensively understand how faculty engage in teaching, mentoring, and supporting these students and how administrators' leadership and support services influence the overall educational landscape in engineering programs at HSIs.

Drawing on existing scholarship emphasizing the importance of diversity, equity, and inclusion in higher education, particularly within engineering, the study will select and analyze approximately 37 peer-reviewed articles and conference proceedings published from 2010 to 2022. Employing predefined inclusion and exclusion criteria, the analysis will focus on identifying faculty and administrator roles in teaching, mentoring, and supporting Latinx and other BIPOC students in engineering, with a systematic and rigorous approach to data analysis.

The study will address two questions: what is the nature of HSI scholarship in engineering education, and, what are the resulting implications for faculty and administrators? By synthesizing existing literature, this systematic review contributes to an understanding of the areas of faculty and administrators' contribution to diversity, equity, and inclusion in engineering education at HSIs, with expected implications for further research.

Introduction

The purpose of this systematic review study is aimed at examining the nature of Hispanic Serving Institution (HSI) scholarship related to engineering education and what implications are drawn for faculty and administrators in engineering at HSIs. Based on the 2021-2022 estimates, approximately one in six colleges and universities in the United States, District of Columbia, and Puerto Rico meet the criteria[1] to be designated as an HSI in the United States [1]. Hispanic Serving Institutions carry the responsibility of educating a large proportion of the nation's racially and ethnically minoritized and low-income students [1]. HSIs play a vital role in attracting, enrolling, and retaining Latinx and Black, Indigenous, and People of Color (BIPOC) students in engineering and computer science programs [2].

HSI scholars have argued that HSIs still mirror the culture and norm of predominately white[2] institutions [3], which do not offer inclusive and equitable environments for Latinx and BIPOC students. These students often encounter racialized experiences even at HSIs, such as biases, microaggressions, exclusion, or discrimination from their peers and faculty [4]. These negative

[1] Hispanic Serving Institutions must enroll at least 25% Latinx-identifying students and 50% Pell-eligible students.

[2] We lowercase the word "white" in this paper to decenter whiteness and amplify the voices of BIPOC communities.

experiences are often reinforced when BIPOC students study STEM majors due to the engineering disciplines' composition as white, middle-class, and male dominated fields [5], [6], [7], [8]. Particularly, Latina students often suffer challenges when they try to belong to engineering disciplines due to the racism and sexism [9], [10], [11]. Nevertheless, HSIs have offered diverse programs to recruit and retain more Latinx and BIPOC students by incorporating Latinx culture and values [12], [2], including family and community members in their outreach and collaborating with professional organizations that support Black and Hispanic engineers and scientists [13], [14]. These efforts have been actively implemented through multiple funding sources; for example, the National Science Foundation (NSF)'s Hispanic Serving Institution grant opportunities [15].

Despite the important contributions of HSIs to engineering education and the engineering workforce, it remains unanswered what kinds of studies have been done in terms of HSIs' servingness in engineering education. Based on our systematic review of STEM education and HSI literature, we found that very few journal articles addressed faculty and administrators' experiences or contributions [16]. Given that the scope of the study was undergraduate education, it was not surprising to see that many of the articles addressed student experiences and perspectives. However, scholars have argued that it is critical to investigate the roles of faculty members and administrators in their teaching, advising, and mentoring commitment for promoting diversity, equity, and inclusion at HSIs [4] [17]. Faculty and administrators are change-makers in institutional policy, practices, and culture [17]. Thus, it is important to learn more about what implications and recommendations can be drawn from the literature for engineering faculty and administrators to improve the environment in terms of inclusivity and diversity for students.

In this study, we choose a systematic review method and followed the processes that Borrego et al. [18], [19] suggest. The articles were chosen based on predefined inclusion and exclusion criteria, with a focus on engineering undergraduate education. We first reviewed the characteristics of the qualifying articles on engineering education at HSIs. We then reviewed the qualifying studies' discussion and implication sections to examine what implications or recommendations have been made from the qualifying studies based on their study findings for faculty and administrators. This systematic review involved selecting and analyzing 37 peer-reviewed articles and conference proceedings about engineering education published from 2010 to 2022. We asked two research questions:

1. What is the nature of Hispanic Serving Institution literature related to engineering education?
2. What are the resulting implications of HSI engineering education literature for faculty and administrators?

This systematic review contributes to the growing body of knowledge on the roles of faculty and administrators in teaching and learning and promoting diversity, equity, and inclusion in engineering education at HSIs. The findings are expected to provide guidance for further research, inform policy decisions, and help shape practices that lead to a more inclusive and

supportive engineering educational environment. Specifically, we offer implications to better serve Latinx and BIPOC engineering students and their communities at HSIs.

Methods

To better understand the implications from existing literature for engineering faculty members and administrators at HSIs, we conducted a systematic review of literature on engineering education at HSIs. This paper is part of a larger project for which we collected article data that addressed STEM undergraduate education at HSIs. With specific inclusion/exclusion criteria [18], we collected 218 articles on STEM HSI education in general. To narrow our focus, we added a criterion to include only articles that addressed engineering undergraduate education, resulting in a final selection of 37 articles for this paper.

Databases and Search Terms

We used four databases: Education Source, Academic Search Complete, Professional Development Collection, and ERIC. After we tried several search terms, we used the final search terms of "Science, Technology, Engineering, Mathematics[3]" and "Hispanic Serving" or "Hispanic-Serving" in the abstract, title, or as keywords. We also included subdisciplines in the search terms, such as bioengineering.

Selection and Screening Process

Inclusion Criteria

Aligned with the principles of a systematic review [18], we established six inclusion criteria (IC): published between 2011 and 2022 (IC 1), written in English (IC 2), contained empirical data published in a peer-reviewed journal or conference proceeding (IC 3), focused on undergraduate students or undergraduate education (IC 4), addressed STEM disciplines directly (IC 5), and addressed engineering education directly (IC 6).

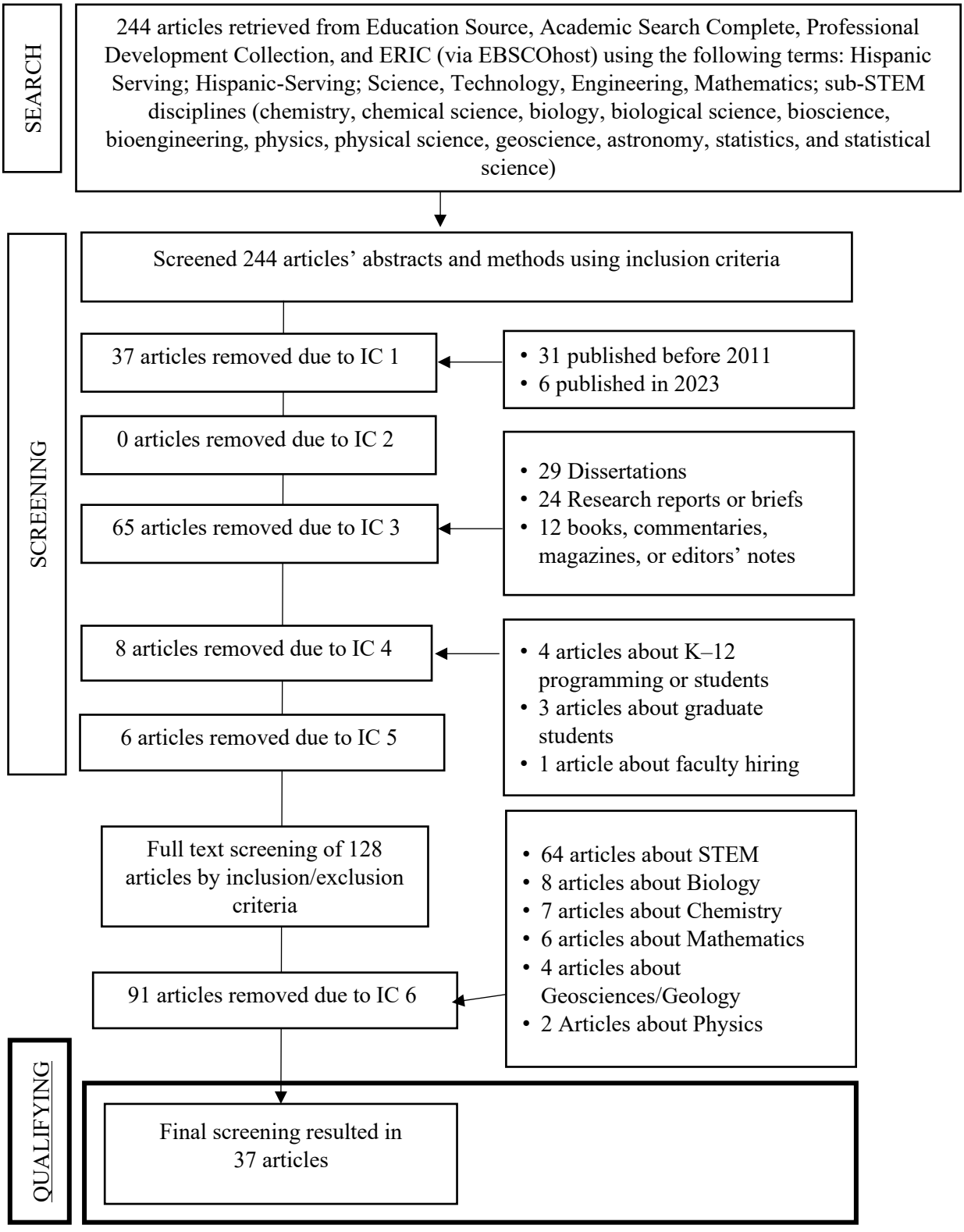
First, we focused on the past decade of publication (IC 1) given that it was a time of significant growth in both engineering education [20] and HSI scholarship [17]. We also limited articles to those written in English (IC 2) because of the U.S.–specific contexts of HSIs. In this study, we excluded theoretical articles, book chapters, book reviews, dissertations, reports, commentaries, or any other non-peer-reviewed publications (IC 3) because peer-reviewed empirical publications are the primary means of disseminating research on engineering education and represent the type of work generally valued within the academy. We also included ASEE conference proceedings because it is one of the main publication outlets for engineering education faculty and researchers. We only included studies on undergraduate education (IC 4), which has different contexts than K-12 education or graduate education. We excluded articles not addressing STEM disciplines (IC 5). Finally, we selected articles that addressed engineering students or engineering disciplines only (IC 6). Thus, if some studies include engineering students as part of the STEM major of students in their study and did not address the uniqueness of engineering students or programs, we did not include them. After we applied the five inclusion criteria, 37 articles

[3] For all of our search terms, we accounted for their singular and plural versions.

remained. Figure 1—a PRISMA flow diagram—illustrates the entire search and screening process.

Figure 1

PRISMA Flow Diagram for Study Selection



Data Analysis

We conducted a comprehensive analysis, utilizing both quantitative and qualitative methods, to investigate the content of the 37 qualifying articles and the implications derived from them. For Research Question 1, we initially tallied the articles based on various study characteristics, including the number of institutions examined (i.e., single or multi-institutional studies), types of institutions, disciplines, funding status, and publication outlets.

In addressing Research Question 2, we initially tallied the articles providing tangible implications or recommendations for faculty and administrators. Subsequently, we employed inductive qualitative data analysis to categorize these implications from the 37 articles. The lead author and second author independently coded all articles, cross-verified each other's coding, and proposed thematic patterns. To enhance reliability, any coding discrepancies were thoroughly discussed until consensus was reached on the coding for each article.

Following the completion of the coding process, we derived overarching themes highlighting the areas of implication presented for faculty and administrators in the qualifying articles pertaining to engineering education at HSIs.

Positionality Statement

As Asian immigrants and Asian American cisgender women, we recognize and acknowledge the interplay of our privileged and marginalized identities within the landscape of higher education and STEM education. Our current roles involve working at HSIs, where we have conducted research on the serving nature of these institutions in our scholarly pursuits. Our professional and scholarly backgrounds shape our perspectives and insights into HSI servingness, given our specific focus on the intersection of Asian identity and the HSIs' mission.

Driven by our commitment to promoting racial equity and social justice, our endeavors are directed towards leveraging the serving nature of HSIs. Through our professional and academic pursuits, we aim to contribute to the advancement of equity in higher education, particularly within the context of HSIs, which aligns with our shared values and aspirations for a more inclusive and just society.

Limitations

Similar to other research endeavors, this study is not without its limitations. Notably, our focus is solely on peer-reviewed journals and conference proceedings. While this approach may have led us to overlook significant contributions in the fields of engineering education, it is essential to underscore that peer-reviewed publications serve as the principal and esteemed channels for disseminating research in these fields.

Another limitation is the exclusion of manuscripts that did not collect or analyze empirical data, such as op-eds, commentaries, and book reviews. While this choice may have resulted in overlooking works centered on theories and literature alone, it was a deliberate decision. Our aim was to concentrate specifically on implications drawn from empirical evidence, excluding commentaries or opinions. Despite these limitations, we believe our chosen methodology aligns with the study's objective and enhances the rigor and reliability of our findings.

Findings

We conducted a quantitative analysis to provide an overview of the 37 qualifying articles, presenting key characteristics. Specifically, we present details at the article level, encompassing participant population, the number of institution(s) studied (single or multi-institutional study), types of institutions, disciplines, funding status, and publication outlet. Table 1 displays the characteristics of the final dataset, while Table 2 offers a summary of the sample organized by publication outlet.

Finding 1: The Nature of the 37 Qualifying Articles

The majority of the articles predominantly focused on students (n = 32), with only five articles exclusively addressing faculty or administrators. Among the 32 articles centered on undergraduate students, nine specifically highlighted Latinx students. Additionally, five qualifying articles concentrated on BIPOC or underrepresented minority (URM) students as a broader category, without making comparisons with white students. Seventeen articles explored all racial groups, including white, Latinx, and other BIPOC students, and conducted comparisons across racial/ethnic groups. One article delved into non-Latinx racial groups at HSIs, emphasizing American Indian students.

Regarding institutional characteristics, 24 qualifying articles adopted a single institutional study approach, while 13 utilized a multi-institutional study approach. The majority of the articles focused on 4-year institutions (n = 31), with two articles exclusively examining 2-year institutions and four studies encompassing both 2-year and 4-year institutions. Among the 37 qualifying articles, 29 studies secured funding from external agencies. While 21 articles received grants from the National Science Foundation, eight obtained funding from other sources, such as the U.S. Department of Education. Notably, the remaining eight qualifying articles were conducted without external funding.

In summary, the majority of the 37 qualifying articles examined engineering students at 4-year HSIs, which aligns with the prevalent focus of STEM undergraduate education on student teaching and learning. Among the qualifying articles, however, empirical studies addressing students from Hispanic-Serving community colleges were scarce. Our review also revealed a lack of studies exploring the experiences and perspectives of engineering faculty and administrators at both 4-year and 2-year HSIs. Notably, nearly 80% of the qualifying articles received external funding, indicating a core interest among external agencies, including the NSF, in diversifying engineering education and fields through HSIs.

Table 1

The Characteristics of Publications in the Final Dataset (N = 37)

	N	(%)
Study Participants		
Students only	32	76%
Faculty/administrators only	5	24%
Race among Students		
All Racial groups	17	46%
Latinx students only	9	24%
BIPOC or URM (including Latinx)	5	13%
Non-Latinx BIPOC students	1	2%
Number of Institutions Studied		
Single institutional study	24	65%
Multi-institutional study	13	35%
Institutional Type		
4-year institutions	31	66%
2-year institutions	2	9%
Both 4-year and 2-year institutions	4	25%
Academic Disciplines		
Engineering	32	86%
Computer Science/Information Technology	5	14%
Funding Status		
Received funding from NSF	21	56%
Received funding from non-NSF sources	8	22%
Did not receive funding	8	22%

In terms of publication outlets, our analysis revealed that 23 qualifying articles were published in STEM education journals, two in general education journals, two in higher education journals, and three in journals specifically focused on Latina/o College Students or Hispanic-Serving Institutions. Additionally, seven other qualifying articles found publication in areas not categorized above. In other words, the majority of qualifying articles were published in STEM education journals, with fewer appearing in educational journals or journals specific to the Hispanic/Latinx community. The empirical studies that address Latinx engineering students at

HSIs may not broadly reach faculty and administrators outside of engineering fields, such as university-wide student affairs practitioners or Latinx scholarly and professional communities. For a detailed breakdown, please refer to Table 2.

Table 2

Journals Identified in the Final Dataset (N = 37)

STEM Education Journals (n = 23)
Proceedings of the ASEE Annual Conference & Exposition (17)
ACM Transactions on Computing Education
Advances in Engineering Education
Computer Applications in Engineering Education
IEEE Transactions on Education
International Journal of Engineering Education
Journal of Mechanical Design
General Education Journals (n = 2)
Journal of Adolescent & Adult Literacy
Journal of American Indian Education
Higher Education Journals (n = 2)
Journal of Diversity in Higher Education
Studies in Higher Education
Latinx Special Focus Journals (n = 3)
Journal of Hispanic Higher Education (2)
Tapuya: Latin American Science, Technology & Society
Other (n = 7)
Journal of Counseling Psychology (3)
Journal of Career Development
Journal of Vocational Behavior (2)
Mind, Culture & Activity

Finding 2: Implications for Faculty and Administrators

Through the analysis of 37 articles on engineering undergraduate education at HSIs, we identified three themes: a lack of tangible implications for faculty and administrators, a consideration of Latinx culture and students, and the imperative for structural and systematic change.

Lack of Tangible Implications

Out of the 37 articles we reviewed, only 14 addressed specific implications for faculty and administrators (38%). The majority of the remaining articles did not explicitly state implications or recommendations for faculty or administrators. Notably, during our examination of the 17 ASEE conference proceeding articles, we observed that all included discussions of their study findings within the context of existing literature. However, it was evident that the discussion or conclusion sections did not contain tangible implications for faculty and administrators. It is worth noting that most ASEE conference proceedings involved single institutional studies, which

could explain why authors may have hesitated to offer implications requiring the generalizability of their study findings.

Consideration for Latinx Culture and Students

The majority of the 14 articles that offered implications on incorporating Latinx culture focused on curricula and emphasizing the roles of faculty. Recognizing the significance of Latinx culture in STEM education at HSIs, researchers proposed ways in which faculty can integrate Latinx culture into engineering curricula. For instance, Mein and Convertino [21] highlighted the necessity of incorporating both English and Spanish in project-based learning to aid Latinx students in developing their engineering identity. Studies on Latinx students underscored the value of their bilingual backgrounds as assets rather than deficits for academic learning [22]. Mein and Convertino [21] recommended that providing content in both English and Spanish could create a more inclusive and validating environment for Latinx students, fostering a sense of belonging in the field of engineering.

Regarding pedagogical approaches, two studies focused on fostering a culture of collaboration. Analyzing social interactions within precalculus-focused jigsaw groups in an undergraduate engineering precalculus course, Convertino and Mein [23] provided insights into the significance of diversity and collaboration for racially minoritized students in STEM education. They suggested that social interactions within peer leaders and jigsaw groups enhanced collaborative and teamwork skills, ultimately contributing to student success. Another study highlighted the importance of a collaborative environment for racially minoritized students participating in architectural design studio's introductory robotics education [24]. Yi [24] emphasized the need to shift the culture of studio teaching from nurturing isolated personal ability to promoting collaboration and collective learning of technological methods with comprehensive application to design projects.

The reviewed 37 qualifying articles underscored the crucial roles of faculty as instructors or mentors at HSIs [14]. Applying Yosso's [22] community cultural wealth framework, Mein et al. [15] identified faculty mentors as central figures and one of the primary supports for Latinx students. Faculty mentors played a pivotal role in helping Latinx students envision themselves as future engineers, a critical contribution given that Latinx students are often overlooked as potential engineers in the fields such as computer science. The authors referred to the contributions of faculty mentors as "positional capital" (p. 2). Another study in computer science emphasized the importance of faculty role models and mentors, highlighting the collaborative efforts of seven HSIs in forming the Computing Alliance of Hispanic-Serving Institutions (CASHI) [25].

Need for Systematic Change

The 37 qualifying articles generally fell short in addressing the imperative for systematic change, with only a handful touching upon this aspect. In alignment with existing literature that recognizes the necessity for structural change in STEM fields, particularly those dominated by white men [2], [8], these studies argued that to effectively recruit and retain racially minoritized individuals in engineering and computing fields, it is essential to intentionally address power dynamics between privileged and oppressed groups, and, societal challenges [11].

For instance, Garriott et al. [11] advocated for altering hiring practices to increase the representation of faculty and staff from underrepresented groups, specifically benefiting Latina women engineering students. Strong et al. [26] emphasized the need for additional funding sources for faculty development, particularly for non-tenured instructors, underscoring their pivotal role in teaching engineering students. Núñez [2] highlighted the importance of structural changes in computing fields within higher education institutions through collaborative efforts with the Latinx community, addressing their unique needs and validating their culture. They argued that without such structural changes, the "servingness" mission of HSIs would not be effectively realized for students.

Furthermore, Núñez et al. [2] extended their focus beyond the classroom environment, studying CASHI programs and activities that promoted values such as confianza (interpersonal and community connections), respeto (moral integrity), and familismo (family connections in Hispanic culture)—values critical in supporting Latinx students throughout their educational journey. The authors recommended the infusion of these cultural values into computing, suggesting that faculty and administrators should incorporate Latinx cultural perspectives as fundamental ways of knowing and learning within the computing discipline. This approach aims to enable Latinx students to perceive and comprehend computing as an integral part of their culture and communities.

Discussion and Implications

In our literature search on STEM education and HSIs, we identified 128 qualifying articles (refer to Figure 1). Upon narrowing our focus to articles specifically centered on engineering disciplines, we found a more limited pool of 37 qualifying articles. Despite the active engagement in scholarship on engineering education, we were surprised by the scarcity of peer-reviewed journal articles and conference proceedings addressing engineering education at HSIs. We recommend that scholars in engineering education conduct more studies on Latinx and BIPOC students at HSIs to enhance our understanding of engineering programs within this context.

A noteworthy finding is that only a quarter of the articles provided tangible implications for faculty and administrators. While scholarly articles may not always explicitly state implications, deriving practical insights from high-quality studies is crucial for informed decision-making and driving policy and practice changes at HSIs. Given the overall scarcity of studies from faculty and administrators at HSIs [17], research addressing STEM education at HSIs should prioritize evidence-based implications. This approach ensures that HSI faculty and administrators can glean valuable insights from future studies and implement program and departmental changes grounded in empirical evidence.

Among the fourteen articles that did offer recommendations, the focus was on how faculty and administrators can integrate Latinx culture into curricula and classrooms as well as provide mentorship to Latinx and BIPOC students. A subset of these articles also addressed strategies for influencing policies, practices, and the overall culture of engineering or computer science programs. However, the existing studies on HSIs tend to concentrate on individual efforts rather than systematic changes. While acknowledging the importance of individual contributions, it

becomes evident that more research is needed to understand how to make the system, policies, and practices more equitable and inclusive for Latinx and BIPOC students at HSIs.

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