

Culturally Relevant Practices at Hispanic Serving Institutions: A Systematic Review of Engineering Education Literature

Dr. Hyun Kyung Ro, University of North Texas

Dr. Hyun Kyung (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.

Culturally Relevant Practices at Hispanic Serving Institutions: A Systematic Review of Engineering Student Experiences

Abstract

Our study is rooted in Garcia et al.'s (2019) framework, which emphasizes Culturally Relevant Programs (CRP) as crucial components of Hispanic-Serving Institutions (HSIs). These programs tailor educational experiences to the unique cultural backgrounds and identities of Latinx students, aiming to enhance their success. Specifically, we delve into the cultural relevance of co-curricular programs within engineering departments at HSIs. Our research seeks to answer two central questions: what are the key characteristics of co-curricular programs for Latinx students in engineering at HSIs, and, what is the extent of their cultural relevance? Identifying the elements of culturally relevant programming covered in the reviewed literature assists us in answering these questions.

Employing a systematic review methodology, we analyzed 37 peer-reviewed articles and conference proceedings published between 2011 and 2022, which were selected from a larger dataset collected as part of our National Science Foundation-funded research. Through this review, we aim to comprehensively assess the design, implementation, and evaluation of co-curricular programs for Latinx engineering students, gathering insights from various stakeholders, including students, faculty, and administrators. Our study seeks to highlight the cultural significance of co-curricular programs at HSIs, aiming to foster the creation of more inclusive and culturally tailored initiatives to support Latinx students.

Introduction

Hispanic-Serving Institutions (HSIs) play a crucial role in attracting and retaining Latinx and Black, Indigenous, and people of color (BIPOC) engineering students in higher education [1]. HSI scholars have emphasized the sense of communal or family orientation among Latinx students in engineering and computing, attributing it to their validated experiences and academic success [2], [3]. However, research and policy reports suggest that STEM programs often fail to incorporate aspects of Latinx culture, such as representations of Latinx faculty, societal issues relevant to Latinx communities, Spanish language, Latinx music, or art [2], [4], [5], [6]. In particular, Núñez et al. [2] indicated that *confianza* (interpersonal and community connections), *respeto* (moral integrity), and *familismo* (family connections in Hispanic culture) in computing are crucial for Latinx computing students' success in Computing Alliance of Hispanic-Serving Institutions (CASHI), a multi-institutional collaboration. Preuss et al. [6] and Sáenz and Ponjuan [7] also emphasized that *familismo* is a vital factor in Latino students' transition into college and in achieving their academic and life goals.

Despite the importance of Latinx culture at HSIs, the question of cultural relevance in engineering curricula, co-curricular programs, or departmental culture at HSIs remains unanswered. Our study is grounded in Garcia et al.'s [8] framework, which encompasses culturally relevant practices (CRP) as one of the aspects contributing to the servingness of HSIs. HSIs take into account the unique cultural backgrounds and social identities of Latinx students to enhance their educational experiences and success [8]. Thus, it is critical to better understand

how culturally relevant practices have been addressed in engineering and computing fields at HSIs. Our research focuses on reviewing existing literature about the culturally relevant practices that have been implemented within or across engineering departments for Latinx and other BIPOC students at HSIs.

We employed a systematic review methodology to analyze a subset of 37 peer-reviewed journal articles and conference proceedings published between 2011 and 2022. These articles were selected from a broader dataset collected as part of our National Science Foundation-funded program for a systematic review of STEM education and HSI servingness. The systematic review enables a comprehensive understanding of the design, implementation, and evaluation of culturally relevant practices and programs in multiple areas for engineering students. Specifically, we sought to gather insights about culturally relevant practices experienced by various stakeholders, including students, faculty, and administrators, from the published articles.

Our study addresses two central research questions:

- What are the key characteristics of the existing literature on culturally relevant practices for Latinx students in the field of engineering and computing at HSIs?
- How are culturally relevant practices aligned with the servingness of HSIs in existing literature?

Conceptual framework

For this project, we utilized Garcia et al.'s [8] Multidimensional Conceptual Framework for Understanding "Servingness." Garcia et al. [8] conducted a systemic review of how researchers conceptualize servingness at HSIs and provided a comprehensive, multidimensional framework for understanding servingness at HSIs. The framework delineates the complex concepts of HSIs, encompassing their historical origin, organizational identity, and socio-political context. This framework aids scholars, practitioners, and policymakers in gaining a more comprehensive understanding of the opportunities and obstacles that HSIs face in fulfilling their mission.

The authors define indicators of serving within outcomes (academic and non-academic), experiences (validating or racialized experiences among students or non-students within the structures), internal organizational dimensions (leadership and decision making; culturally relevant curriculum or pedagogy; culturally relevant practices and programs); and external influences on serving (federal and state policy). In this study, we approach culturally relevant practices broadly to include culturally relevant curricula, pedagogies, co-curricula, and departmental/disciplinary practices.

The framework highlights the complexity of defining servingness within HSIs and of progressing along the spectrum to become a Latinx-serving institution. Garcia et al. [8] contend that researchers should position their design and analysis of HSIs through equity and anti-deficit practices. These culturally relevant, asset-based approaches help researchers, practitioners, and policymakers implement positive organizational, societal, and individual outcomes through HSI contributions [8], with culture playing a critical role in cultivating successful outcomes at HSIs [2], [6]. Based on this framework, we examine the characteristics of existing literature on culturally relevant practices and how these practices are connected to the servingness of HSIs as defined by Garcia et al.'s [8] framework.

Methods

To gain a comprehensive understanding of culturally relevant practices offered at HSIs, we conducted a systematic review of literature focusing on engineering education within Hispanic-Serving Institutions. This research is part of a larger project in which we compiled articles addressing STEM undergraduate education at HSIs. Employing inclusion/exclusion criteria [9], we initially gathered 218 articles related to STEM education at HSIs. For the specific focus on engineering undergraduate education in this paper, we refined our criteria, resulting in a total of 37 articles.

Databases and search terms

We utilized four databases: Education Source, Academic Search Complete, Professional Development Collection, and ERIC. After experimenting with various search terms, our final criteria included “Science, Technology, Engineering, Mathematics” and “Hispanic Serving” or “Hispanic-Serving” in the abstract, title, or keywords. We also incorporated subdisciplines, such as bioengineering, to ensure a comprehensive search.

Selection and screening process

Inclusion criteria

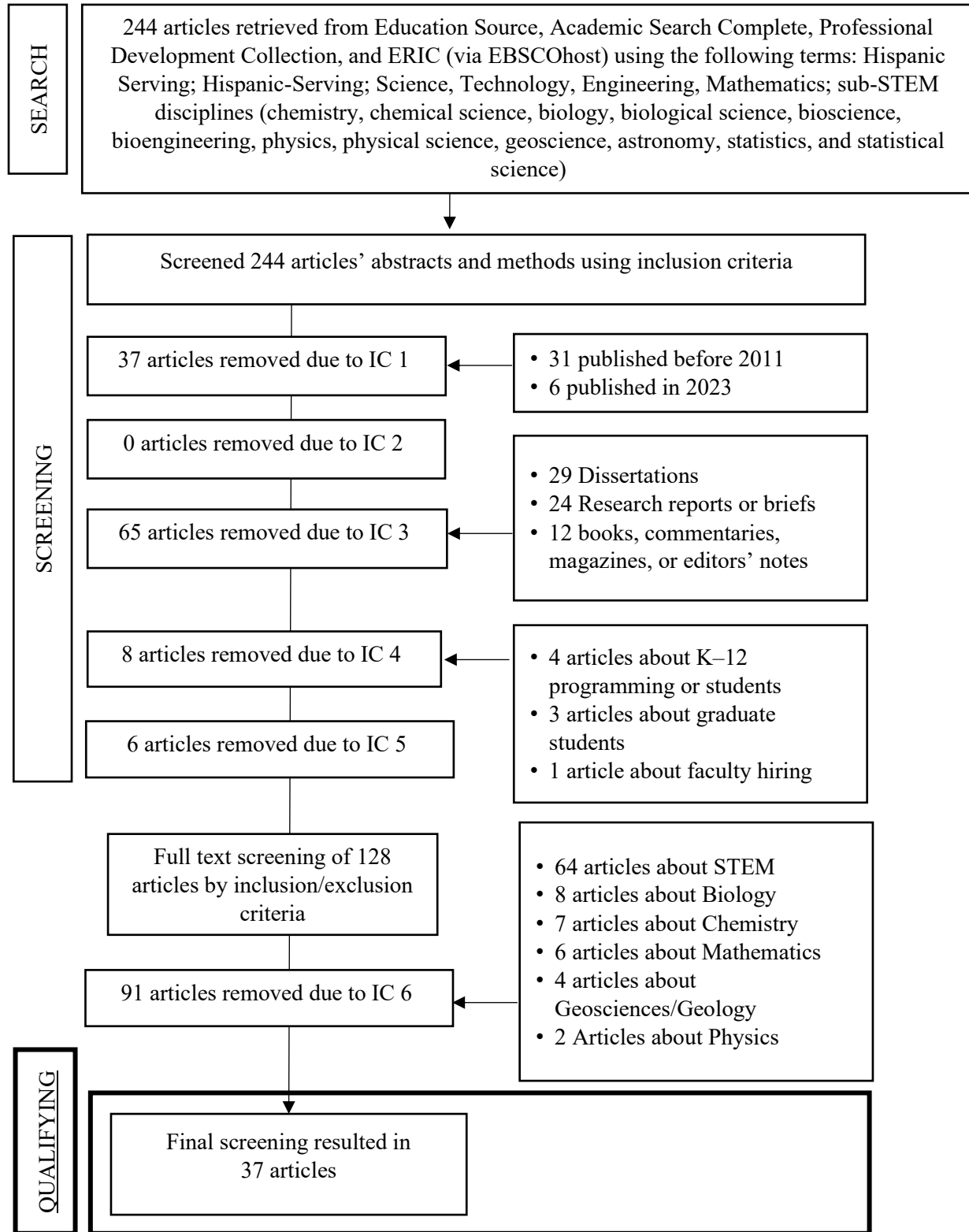
Aligned with systematic review principles [9], we established six inclusion criteria (IC):

- 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 (IC 5); and
- Addressed engineering education directly (IC 6).

We selected the time frame of 2011 to 2022 (IC 1) to capture the growth in HSI scholarship over the past decade [10]. Considering the specificity of HSIs to the U.S. context, we limited articles to those written in English (IC 2). Non-peer-reviewed publications were excluded (IC 3), emphasizing the importance of peer-reviewed empirical work in disseminating research on engineering education. ASEE conference proceedings, a significant outlet in engineering education, were included. Our focus remained on undergraduate education (IC 4), given its unique context is different from K-12 education or graduate education. We excluded articles not addressing STEM disciplines directly (IC 5). Lastly, articles were selected only if they directly addressed engineering students or engineering disciplines (IC 6). Studies that included engineering students as part of STEM major participants but did not specifically address the uniqueness of engineering students or programs were excluded. Figure 1, a PRISMA flow chart, describes the entire search and inclusion/exclusion process.

Figure 1

PRISMA Flow Diagram for Study Selection



Data analysis

We reviewed the 37 qualifying articles to investigate the characteristics of culturally relevant practices for Latinx students within the servingness of HSIs. For Research Question 1, quantitative approaches were employed, counting the number of articles based on the general characteristics of the studies. The analysis included a review of funded studies, targeted groups (e.g., Latinx, Latina women, or BIPOC in general), targeted institutions (2-year or 4-year), and who was studied (students, faculty, administrators, or professionals, within or outside STEM programs).

In addressing Research Question 2, a combination of quantitative and qualitative approaches was used. A deductive approach was employed when coding, using Garcia et al.'s [8] multidimensional conceptual framework of servingness at HSIs as a starting point [11]. The main seven components of the framework were initially used to analyze the data, including academic outcomes, non-academic outcomes, student experiences, non-student experiences, leadership decision making, culturally relevant curriculum or pedagogy, culturally relevant practices, and external influences. Subcategories provided by Garcia et al. [8] were incorporated during the coding process to add depth and specificity. Themes specific to the STEM context were also included in the codebook.

The lead author and second author independently coded all articles, cross-verified each other's coding, and proposed thematic patterns. Coding discrepancies were discussed until consensus was reached for each article. Following the completion of the coding process, overarching themes were derived, highlighting the areas of HSI servingness through culturally relevant practices and programs.

Positionality statement

As Asian immigrants and Asian American cisgender women, we acknowledge the interplay of our privileged and marginalized identities within the higher education and STEM education landscape. Our roles involve work at HSIs, where we have conducted research on servingness in our scholarly pursuits. Our professional and scholarly backgrounds shape our perspectives on HSI servingness, with a focus on the intersection of Asian identity and the institutions' mission. Driven by our commitment to racial equity and social justice, our efforts aim to leverage the serving nature of HSIs.

Limitations

This study has limitations, including its focus solely on peer-reviewed journals and conference proceedings. Another limitation is the exclusion of manuscripts without empirical data. While this approach may overlook significant contributions in engineering education, it emphasizes the principal channels for disseminating research in the field.

Findings

Research Question 1: What are the key characteristics of the existing literature on culturally relevant practices for Latinx students in the field of engineering and computing at HSIs?

Table 1 displays the study characteristics of the 37 qualifying articles, with a specific emphasis on those addressing culturally relevant practices. This section delves into the key characteristics

of culturally relevant practices embedded for Latinx and other BIPOC students in STEM fields at HSIs. Out of the 37 qualifying articles, 21 (57%) highlighted the importance of Latinx culture in STEM learning, employing asset-based approaches to understand Latinx students and shedding light on the isolated culture of STEM disciplines against Latinx individuals.

The majority of studies focused on students, 17 in total, as these studies delved into students' learning and success. There were 21 qualifying articles that targeted Latinx students exclusively (n = 7), BIPOC students including Latinx (n = 4), or conducted comparisons between BIPOC and Whites (n = 5). Additionally, a few studies (n = 4) examined faculty and administrators' perspectives, addressing the organizational culture within engineering and computing departments.

In terms of institutional focus, the majority centered on 4-year institutions (n = 18), with one study exclusively conducted at a 2-year institution, and two articles involving both 2-year and 4-year institutions. Regarding academic majors, 17 articles focused on engineering, while four 4 articles centered on computer science majors at HSIs.

Furthermore, 10 articles received grants from the National Science Foundation and six obtained funding from other sources such as the U.S. Department of Education. Notably, the remaining 5 qualifying articles were conducted without external funding. This overview provides insights into the diverse characteristics of the studies addressing culturally relevant practices for Latinx and BIPOC students in STEM fields at HSIs.

Table 1

The Characteristics of Publications in the total articles (N = 37) and articles on culturally relevant practices (N = 21).

	Total Articles (N = 37)		CRP articles (N = 21)	
	N	(%)	N	(%)
Study Participants				
Students only	32	76%	17	81%
Faculty/administrators only	5	24%	4	19%
Race among Students				
Latinx and other racial students	17	46%	5	29%
Latinx students	9	24%	7	41%
URM or BIPOC	5	13%	4	24%
Non-Latinx BIPOC students	1	2%	1	6%
Number of Institutions Studied				
Single institutional study	24	65%	11	52%
Multi-institutional study	13	35%	10	48%
Institutional Type				
4-year institutions	31	66%	18	86%
2-year institutions	2	9%	1	5%
Both 4-year and 2-year institutions	4	25%	2	9%
STEM Fields				
Engineering	32	86%	17	81%
Computer Science/Information Technology	5	14%	4	19%
Funding Status				
Received funding from NSF	21	56%	10	48%
Received funding from non-NSF sources	8	22%	6	28%
Did not receive funding	8	22%	5	24%

Research Question 2: How culturally relevant practices are aligned with the servingness of HSIs in existing literature?

Similar to Garcia et al.'s [8] study, the majority of the 21 qualifying articles focused on student outcomes and experiences. Given that an article can often address multiple components and subcomponents of servingness, 10 articles delved into academic outcomes (e.g., persistence, transfer, graduation), while 6 articles explored non-academic outcomes (e.g., self-efficacy, learning outcomes). Moreover, 9 articles exclusively examined student experiences within and beyond the classroom. This research line predominantly emphasized students—both their outcomes and experiences, with only 2 articles addressing faculty members' experiences in teaching.

Comparatively less emphasized than student-centered studies, out of the 21 qualifying articles, 5 addressed culturally relevant curricular content and/or pedagogies and one article covered culturally relevant co-curricular programs and/or practices. Mirroring Garcia et al.'s [8] study, a smaller number of studies focused on leadership and decision-making (n = 6) and external factors (n = 2). Table 2 provides a breakdown of the frequencies for each component of HSI servingness derived from the articles on culturally relevant practices within Engineering education research.

Table 2

Components of HSI Servingness and culturally relevant practices in engineering, 2011–2022

	CRP articles (N = 21)	
Outcomes	12	
Academic outcomes		10
Non-academic outcomes		6
Experiences	11	
Student experiences		9
Non-student experiences		2
Culturally relevant curriculum and/or pedagogy	5	
Culturally relevant programs and/or practices	1	
Leadership/Decision making	6	
External factors	2	
Total ^a	37	

Note. ^a One article can address more than one component of servingness as well as more than one sub-component, so the number of articles exceeds 21 – the total number of unique articles that addressed culturally relevant practices.

Discussion and implications

Despite Hispanic-Serving Institutions (HSIs) enrolling a significant number of Latinx and low-income students, our review reveals that slightly more than half of the qualifying articles (57%) addressed cultural aspects in their studies. Several studies specifically highlighted Latinx culture, recognizing the diversity within the Latinx community. For example, Yilmaz [12] focused on the context and culture of Mexico through the New Mexico Alliance for Minority Participation (AMP) program for BIPOC students. These studies underscored the importance of family values [13] and faculty support [14]. Convertino and Monarrez [15] argue that understanding Latinx students through asset-based approaches rooted in their home culture and faculty members' better understanding Latinx culture is crucial for the students' success in engineering and computing fields.

We found several studies addressed engineering and computing students with diverse racial and gender backgrounds. Some articles emphasized the significance of Latinx culture for Latina students, particularly due to the gendered racism prevalent in STEM environments [16], [17]. Interestingly, there is no study that focused on Latino students, thus more studies are needed to address Latinx students with different social identities. Furthermore, all studies centered on Latinx students' experiences and outcomes, except for one article that studied Native American

Indian students at HSIs and TCUs [18]. HSIs contain a high percentage of non-Hispanic racially minoritized college students on campus [19]. Recently, a few studies examined Black students' validated and racialized experiences at HSIs [20], [21], but these studies did not consider the unique context of academic disciplines. More studies are needed to study the servingness of HSIs for other racially minoritized students.

Similar to Garcia et al.'s [8] systematic literature review, our findings indicate that most manuscripts on engineering education at HSIs primarily focus on academic outcomes. This aligns with the National Science Foundation's emphasis on success measures such as enrollment, persistence, and graduation among Latinx and other students of color in STEM majors. While these outcomes are essential, it is noteworthy that about half of the qualifying articles did not address cultural aspects. Given that 80% of the studies were supported by NSF and other grants, it is critical to scrutinize whether funded programs intend to incorporate and implement cultural changes rather than focusing solely on individual fixes. We identified only a few studies addressing the cultural aspects in student learning and outcome assessment within curricula [22], [23].

Internships, a common high-impact practice in higher education institutions, especially for engineering students, were also explored. Rentsch & Enriquez [24] provided insights into internships by better considering the needs and characteristics of Hispanic-Serving Community College students. While internships are acknowledged as valuable, more studies should intentionally incorporate Latinx culture into internship programs. Understanding how internship experiences can disrupt the observed racism and sexism in engineering fields is crucial. Research in this area can shed light on the benefits of internships, particularly for students who did not graduate from highly selective research universities, providing opportunities to learn more about the industry and develop social and cultural capital [25]. Expanding studies in this direction can contribute to creating more inclusive and equitable internship experiences.

Conclusion

Our research aims to illuminate culturally relevant practices in engineering and computing within the context of HSIs, with the goal of promoting the development of more inclusive and culturally relevant practices tailored to meet the unique needs of Latinx students. We anticipate that our findings will offer valuable insights for engineering and computing programs at HSIs, benefiting faculty, administrators, and professionals dedicated to serving Latinx and other BIPOC students.

Acknowledgements

This project received support from the United States National Science Foundation under the Improving Undergraduate STEM Education: Hispanic Serving Institutions (HSI) program, Award #2122917. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

References

- [1] Excelencia in Education (2023a). “Hispanic-serving institutions (HSIs): 2021–22,” 2023. [Online]. Available: <https://www.edexcelencia.org/media/2105>
- [2] A. M. Núñez, J. Rivera, J. Valdez, and V. B. Olivo. “Centering Hispanic-serving institutions’ strategies to develop talent in computing fields,” *Tapuya: Latin American Science, Technology and Society*, vol., 4, no. 1, pp. 1-20, 2021.
- [3] E. J. López, V. Basile, M. Landa-Posas, K. Ortega, and A. Ramírez. “Latinx students’ sense of familismo in undergraduate science and engineering,” *The Review of Higher Education*, vol. 43, no. 1, pp. 85-111, 2019.
- [4] J. Morales-Chicas, M. Gomez, M. Gussman, and C. Kouyoumdjian. “A cultural wealth approach to understanding Latin@s’ STEM mentee and mentor experiences,” *Equity & Excellence in Education*, pp. 1-15, 2022.
- [5] National Academies of Sciences, Engineering, and Medicine, “Minority-serving institutions: America’s underutilized resource for strengthening the STEM workforce,” The National Academies Press, Washington, DC (USA), 2018. Available: <https://doi.org/10.17226/25257>
- [6] M. D. Preuss, E. M. Sosa, J. C. Rodin, C. R. Dorsett, J. D. Ramos, and C. R. Burlison. “Students at Hispanic-Serving Institutions (HSI) in Texas and New Mexico: An in-depth profile of their backgrounds, commitments, and perspectives,” *International Journal of Research in Education and Science*, vol. 7, no. 2, pp. 287-326, 2021.
- [7] V. B. Sáenz and L. Ponjuan. “Men of color: Ensuring the academic success of Latino males in higher education,” Institute for Higher Education Policy, November 2011.
- [8] G. A. Garcia, A. M. Núñez, and V. A. Sansone. “Toward a multidimensional conceptual framework for understanding ‘servingness’ in Hispanic-serving institutions: A synthesis of the research,” *Review of Educational Research*, vol. 89, no. 5, pp. 745-784, 2019.
- [9] M. Borrego, M. J. Foster, and J. E. Froyd. “Systematic literature reviews in engineering education and other developing interdisciplinary fields,” *Journal of Engineering Education*, vol. 103, no. 1, pp. 45-76, 2014.
- [10] P. Marin and S. Aguilar-Smith. “The evolving portrayal of Hispanic-serving institutions? A systematic review of more than 20 years of research,” *Journal of Hispanic Higher Education*, vol. 22, no. 4, pp. 446-459, 2023.
- [11] M. B. Miles and A. M. Huberman, *Qualitative data analysis: An expanded sourcebook*, 2nd Ed., Thousand Oaks, CA: Sage, 1994.
- [12] N. Yilmaz, F. M. Vigil, M. Trujillo, L. Acevedo-Rodriguez, and R. B. Jacquez. “Influence of NSF-funded undergraduate research assistantships on underrepresented minority students,” in *ASEE Annual Conference & Exposition*, Indianapolis, IN (USA), June 2014. <https://doi.org/10.18260/1-2—20636>.

- [13] Gates et al. "The computing alliance of Hispanic-serving institutions: Supporting Hispanics at critical transition points," *ACM Transactions on Computing Education (TOCE)*, vol. 11, no. 3, pp. 1-21, 2011.
- [14] S. P. Kang, Y. Chen, V. Svihla, A. Gallup, K. Ferris, and A. K. Datye. "Guiding change in higher education: An emergent, iterative application of Kotter's change model," *Studies in Higher Education*, vol. 47, no. 2, pp. 270-289, 2022.
- [15] C. Convertino and A. Monarrez. "Storylines in figured worlds: Understanding diverse college students' decision to major in computer science," *Journal of Diversity in Higher Education*, vol. 14, no. 3, pp. 374-385, 2021.
- [16] [11] P. O. Garriott et al. "Surviving and thriving: Voices of Latina/o engineering students at a Hispanic serving institution," *Journal of Counseling Psychology*, vol. 66, no. 4, pp. 437-438, 2019.
- [17] E. Mein, A. Esquinca, L. Herrera-Rocha, and H. Muciño Guerra. "Identity and persistence among Latinx engineering students at a research intensive Hispanic-Serving Institution," *Journal of Hispanic Higher Education*, vol. 22, no. 4, pp. 432-445, 2023.
- [18] G. G. Kodaseet and R. Varma. In pursuit of a computing degree: Cultural implications for American Indians. *Journal of American Indian Education*, 51(1), 67-88, 2012.
- [19] Hispanic Association of College and Universities, "Hispanic-Serving Institution quick facts, 2023. [Online]. Available: https://www.hacu.net/hacu/HSI_Fact_Sheet.asp
- [20] E. J. Abrica, C. García-Louis, and C. D. J. Gallaway. "Antiblackness in the Hispanic-Serving Community College (HSCC) context: Black male collegiate experiences through the lens of settler colonial logics," *Race Ethnicity and Education*, vol. 23, no. 1, pp. 55-73, 2020. <https://doi.org/10.1080/13613324.2019.1631781>
- [21] W. N. Pirtle, B. Brock, N. Aldonza, K. Leke, and D. Edge. "I didn't know what anti Blackness was until I got here': The unmet needs of Black students at Hispanic-Serving Institutions," *Urban Education*, vol. 59, no. 1, pp. 330-357, 2021. <https://doi.org/10.1177/004208592110449489>
- [22] P. K. Cornejo and K. Orner. (2019, June). "Life cycle thinking and engineering in developing communities: Addressing international sustainability challenges in the classroom," in *2019 ASEE Annual Conference & Exposition*, Tampa, FL (USA), June 2019. <https://doi.org/10.18260/1-2--33065>
- [23] H. Yi. "Robotics and kinetic design for underrepresented minority (URM) students in building education: Challenges and opportunities," *Computer Applications in Engineering Education*, vol. 27, no. 2, pp. 351-370, 2019.
- [24] N. P. Rentsch and A. G. Enriquez. "Improving engineering curriculum and enhancing underrepresented community college student success through a summer research internship program," in *2014 ASEE Annual Conference & Exposition, Indianapolis, IN (USA)*, pp. 24-716, June 2014, <https://doi.org/10.18260/1-2--20608>.

[25] V. A. Sansone et al. “Developing work-based geosciences learning opportunities in a Hispanic-serving institution,” *New Directions for Student Services*, vol. 2019, no. 167, pp. 85-99, 2019.