Board 437: Work in Progress: Transforming STEM Undergraduate Education Through a Hispanic Student Success Servingness Framework

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Given the need for continued scientific innovation and a diverse, skilled STEM (science, technology, engineering, and mathematics) workforce in the United States, increasing the representation of women, Hispanic, Black, first-generation, and other underrepresented groups in STEM is vital [1]. Hispanic-Serving Institutions (HSIs) are recognized for enrolling a large proportion of students from lower income, first generation, and racially marginalized backgrounds [2, 3]. Additionally, Hispanic students earn STEM degrees at high rates at HSIs [4]; in 2016, 46% of Hispanic students who earned STEM bachelor's degrees graduated from HSIs. HSIs have the potential to play an important role in closing national gaps in STEM degree attainment and workforce needs through intentional policies, practices, and institutional commitment [2, 5].

An institutional transformation project focused on STEM undergraduate student success and servingness is underway at a public R1 Hispanic-Serving Institution (HSI) in the southern region of the United States. The university enrolls almost 35,000 students, 59% of whom are Hispanic [6]. About 30% percent of undergraduate students are enrolled in the College of Engineering and the College of Sciences. However, the first-year retention rate is 69% and six-year graduation rate is only 31% for the College of Engineering, with slightly lower rates for College of Sciences. Several courses at the university experience substantial failing rates, as high as 31% to 55% in some gateway and required courses for engineering majors, which act as a major obstacle to degree completion for many students at the university. This work-in-progress poster presentation will provide an overview of the 5-year NSF grant collaboration between engineering and education faculty and leaders at an HSI. Additionally, the poster will highlight the educational research methods and progress from the first two years of the project.

Framework

The grant project is guided by the HSI servingness framework [7]. Institutions are federally classified as HSIs if their full-time equivalent undergraduate enrollment is at least 25% Hispanic and 50% low-income. Beyond the enrollment requirement, there is no formal guidance or accountability for HSIs to truly serve their students and provide the supports that students need or target such service to Hispanic students [3, 8]. Research suggests that understanding how to best serve students at HSIs requires a multidimensional approach and commitment at the organization/institutional level [7]. Indicators of servingness include academic outcomes (e.g., GPA, retention, graduation, degree attainment), non-academic outcomes (e.g., identity development, belonging, critical consciousness, leadership identity), and student experiences on campus (e.g., campus climate, positive interactions with peers and faculty that validate identities). Structures for serving include policies, leadership, curriculum, pedagogies, and

programs. By aligning institutional change strategies with the HSI servingness framework, and confronting systemic racism, meritocracy, and whiteness in higher education and in STEM [9, 10], all students at the university are expected to thrive and be well-supported, including Hispanic students and other students from marginalized backgrounds.

Project Objectives and Progress

The overall goal of the grant is to develop an HSI STEM servingness framework to improve STEM student learning, belongingness, and success, especially for Hispanic STEM students. The project objectives are listed below, and the activities and progress through the first year and a half are briefly described.

Objective 1: Development of an HSI Student Success Servingness Framework

An HSI servingness framework for STEM will be developed using a qualitative, interview-based approach. Semi-structured interviews with 41 STEM undergraduates at the university have been conducted and analysis is underway. Details about the study are included later in this paper. Additionally, focus group interviews with university staff, faculty, and leadership will be conducted in Years 2-3 to obtain their perspectives on policies and practices that support STEM undergraduate success and further identify change strategies and policies that align with HSI servingness. Findings will be used to create recommendations for institutional change and reduce educational barriers to best serve all STEM students at the university, including Hispanic students.

Objective 2: Pedagogical development of engineering courses focused on Computational Literacy and Open Educational Resources

The second objective focuses on developing and implementing novel pedagogical approaches to improve instruction and learning in undergraduate engineering courses with historically high failing rates. Such courses are being restructured, and a set of open educational resources (OERs) are being developed, implemented, and tested [11]. OERs include lecture, laboratory, and recitation materials in electronic form, homework and laboratory assignments, a dedicated website, and other materials such as recordings from instructors covering course contents. OERs will be made available in two languages: English and Spanish. Three courses are included in this effort: Differential Equations and Linear Algebra, Numerical Methods, and Thermodynamics. Academic performance, retention, and students' feedback obtained through surveys and interviews will be used to measure curricular outcomes. Websites to disseminate OERs will begin to be developed over the next year.

Objective 3: Review of current policies, practices, and structures for undergraduate students with a focus on diversity, equity, and inclusion

University policies will be reviewed and revised to support student success. Institutional data (e.g., onboarding access, retention, degree completion, excellence) is being disaggregated by demographic factors, like race/ethnicity, gender, financial need, and transfer status to enhance data-informed, equity-focused decision making at the university. At the end of Year 1, 30% of data was disaggregated, and 23% was in progress. Additional policies that impact undergraduate student success are being identified and revised, such as those pertaining to transfer students, student-facing petition forms, and credit hours, grades, and courses that impact degree attainment.

Objective 4: Development and expansion of a peer mentoring program and TA teaching academy

Peer mentoring and a teaching assistant (TA) teaching academy will be expanded [12]. The peer network expansion will connect students with alumni and mentors for networking, interviewing, and job preparation. Mentoring engagement will be quantified, and student outcomes will be assessed with surveys and resume reviews. TA teaching will be enhanced through institutional programs and policies that prepare STEM TAs to instruct undergraduates using inclusive, evidence-based teaching methods. A pilot program with six College of Engineering grad students/TAs is underway, with plans to expand to the College of Sciences. Outcomes will be measured using interviews, surveys, reflective writings, and peer teaching observations.

Educational Research

This poster will highlight an IRB-approved qualitative study that is being conducted as part of the grant project. The research is guided by the HSI servingness framework [7]. The overall purpose of the research is to understand the ways in which the university is serving its STEM students, using a mirror approach [13] to study and self-reflect on the institution, hereby focusing on the organization as the main unit of analysis. Findings from this research will directly inform plans and actions to revise policies and practices at the university as well as provide implications and recommendations for student success and belongness at HSIs. The following overarching research question will guide this study: How do STEM undergraduate students describe servingness in terms of their experiences with STEM curriculum, sense of belonging, policies, and support services at the university?

Participant Recruitment

The research team, consisting of one faculty (Co-PI), one postdoctoral fellow, and four graduate research assistants (2 PhD, 2 Master's), recruited STEM undergraduate students for the study by visiting five sections of engineering courses and five student organizations (primarily STEM-focused) meetings, although the invitation was open to students in all sections of the engineering courses and to all members of the selected student organizations. Additional students learned about the research by word of mouth and contacted the research team to participate. Students in the College of Engineering and College of Sciences were eligible for the study; majors such as kinesiology and psychology, which are sometimes considered STEM majors, belonged to a different college at the university and were not eligible. Additionally, juniors and seniors were prioritized, as they were expected to have more experiences to comment on for the research.

During the in-person visits, the research team explained the research and provided an opportunity for students to sign up for the study, using paper and digital sign-up forms. On the form, students provided demographic information (e.g., year, gender, ethnicity, major, transfer status) and contact information if they wished to be considered for the study. A total of 235 students indicated that they were willing to be interviewed. Using eligibility criteria and purposeful sampling [14] based on student identities and demographics to obtain a representative sample of students at the university, the research team sent emails and text messages to 120 students to invite them for interviews. The invitation contained a link for students to self-select an interview time that was convenient for them.

Data Collection

Semi-structured individual interviews with 41 STEM undergraduate students were conducted on campus during summer and fall of 2023. Research participants were reminded about confidentiality and the goal to leverage underrepresented students' voices to reassure them and encourage candid responses. Two interviews were fully conducted in Spanish to support students' preferences. A 13-question protocol guided the interviews. Interview topics included students' background information; STEM knowledge and skills; STEM curricular experiences; knowledge and perceptions of career opportunities, campus support services, and campus policies; and perceived sense of belonging. Interviews were audio recorded, and notes/memos were typed after each interview. Interviews lasted 31 to 112 minutes (average 57 minutes).

The sample included 23 male students (56%) and 18 female students (44%). A majority (63%) identified as Hispanic, Latina/o, Chicana/o, or Mexican American, followed by White (24%), Asian American (5%), and Middle Eastern (2%). About half of the sample were transfer students (56%). Most participants were engineering majors (76%), including civil, mechanical,

computer/electrical, biomedical, and chemical. The remaining students (24%) were science majors, such as biology, chemistry, physics, math, geosciences, and microbiology.

Data Analysis

Audio recordings were transcribed, and transcripts were de-identified prior to formal data analysis. A codebook is being developed from one student's exemplar interview that was nearly two hours and full of rich, detailed experiences and perspectives. The codebook will outline all codes that will be used to organize and reduce the data into a few major themes. The code development will be guided by the framework [7] and relevant literature, and codes will be modified and added as needed to fully represent students' experiences [15]. Once the initial codebook is created, the research team will establish intercoder reliability to ensure consistent coding and analysis across different researchers [16]. Then, team members will independently analyze transcripts using the Dedoose software (version 9.0.107). Coding will proceed through stages to generate cross-cutting themes [15]. Member checks will be performed by sharing preliminary findings with participants and asking for edits and clarification to enhance trustworthiness of the findings and support students' involvement in the research and institutional change process [14].

Limitations

Due to a lack of Black/African American STEM students and white female STEM students in the current sample, additional recruitment and interviews will continue this year to obtain a more representative sample of all STEM students at the university. It should also be noted that not all student identities and intersectionalities are represented in the study, such as transgender and nonbinary students.

Preliminary Themes

Qualitative analysis of the student interviews is in progress, but we have noticed some preliminary themes and ideas that were voiced throughout multiple interviews. One example is related to students' perceptions of diversity and sense of belonging at the university. Students across racial/ethnic identities expressed that they like how diverse South University (pseudonym) is and how diversity is valued and celebrated at the university. For several students, this played an important role in their college selection. A Mexican American male student shared, "I feel comfortable knowing that as someone who is Hispanic that my culture is reflected in the values that South University has. … I definitely feel at home here. I don't feel discriminated against or a minority whatsoever." When asked about what he likes about the university, a white male student majoring in mechanical engineering said, "The first thing that came to mind was the diversity … It's more than just, 'Oh, here at South University, we encourage diversity.' It's

‘Here at South University, it is diversity.’” He also commented on his sense of belonging as a white student and what being at an HSI meant to him, sharing that he felt like the university puts students on “the same level playing field.”

However, there is also evidence of gendered experiences for female STEM students and negative interactions with peers and faculty that reduce feelings of belonging. A Latina civil engineering major commented about interactions with men in some of her courses:

> Sometimes the men in the STEM major like can be very demeaning. Like, … yes, they'll be like your friend, but … if you're female and don't understand a concept, … you can tell that they're very judgmental. … The females, we tend to like group together in projects and things like that. … Just so we can actually like, have a support system and not feel like some guy is gonna come in and tell us what to do.

In their STEM classrooms and coursework at the university, many of the undergraduate students expressed how they learn best when instructors incorporate relevant examples into their lectures and provide ample opportunities to practice problems, both in and outside of class. Traditional PowerPoint lectures with minimal interaction and engagement from students was viewed as less effective for their learning. One Hispanic male student shared, “Dr. Moore [pseudonym], … he does a PowerPoint, but he works problems with it … you’re not just like, talking about it, you’re, you’re showing us, you’re making us do it ourselves as well.”

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