A Systematic Review of Literature on Latino Transfer Students in Engineering

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Julie P. Martin, Ph.D. is an associate professor of Engineering and Science Education at Clemson University. Her research agenda has focused on diversity and inclusion in engineering education. In particular, her NSF-funded CAREER work has investigated how social relations—operationalized as social capital—influence student academic decisions and success, especially for underrepresented and underserved students. Her CAREER research supports the need for continued proactive outreach, educational and support systems that have the potential to form "resource-rich" networks in which students receive information and resources in routine exchanges. Dr. Martin's current projects evolve her prior research on social and cultural capital away from a normative state that requires students to conform to the mainstream institution of engineering education. In addition to research, she is deeply interested in STEM education policy, and held a Science and Technology Policy Fellowship with the American Association for the Advancement of Science (AAAS) in 2012-2013. Dr. Martin has held a variety of national leadership positions during her decade-long involvement in ASEE and Women in Engineering ProActive Network (WEPAN). In 2016, she won the ASEE Educational Research and Methods Division Distinguished Service award.

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Background

The 2012 report from the President's Council of Advisors on Science and Technology (PCAST) calls for producing one million more STEM college graduates in the following decade than previously forecast.[1] To achieve this goal, "[a]dult and working students and those from backgrounds atypical of traditional STEM students may need alternative pathways to be successful in STEM disciplines,"[1] particularly those students who have historically been underserved by higher education.[2] The report urges stakeholders to consider that "students who need non-traditional pathways to STEM degrees require special attention" (p. 30). Since we could not find comprehensive reviews of studies to support the preceding recommendations, we undertook a systematic literature review focusing on a critical subset of underrepresented students: 2-year to 4-year Latino transfer students. Separately studying underrepresented groups in STEM is important because access to higher education and transfer patterns differ between student groups.[3] We chose this student group for several reasons. First, recent reports from National Academies argue for leveraging 2-year to 4-year transfer in meeting the STEM workforce demand.[4, 5] Second, Latino students disproportionately graduate from 2-year institutions with the intention to transfer and pursue a bachelor's degree within a 4-year institution.[4] In fact, 45% of Latino STEM students pursuing higher education in 2012 attended public, 2-year colleges.[6] Third, Latino students are the largest of minority populations underrepresented in STEM fields.

When focusing on transfer students, it is important to recognize that several studies have established that first-time enrollees at 2-year institutions are less likely to earn bachelor's degrees than students starting at 4-year institutions.[4] Most challenges occur prior to successful transfer, because students who successfully transfer to 4-year institutions are no less likely to earn a bachelor's degree than students who enrolled in the 4-year institution initially.[7] Students enrolled at 2-year institutions often face distinct barriers different from native 4-year student populations, which reinforces the urgency of a systematic review of interventions to address these findings.

Two-year and 4-year institutions, separately and in partnerships, have implemented various interventions designed to address the preceding findings and results have been published across a wide variety of journal papers, conference proceedings, reports, and dissertations. However, findings from these individual studies have not been previously synthesized to form a comprehensive portrait of interventions that have been implemented together with an examination of the evidence supporting their efficacy. Therefore, a systematic review of existing primary studies to identify and organize interventions supporting Latino STEM students that matriculate at 2-year institutions is needed.

Methodology and Results

A systematic review can provide an overview of individual studies, illuminating both what is known and not yet known about the focus of the review. The comprehensive nature of a

systematic review provides a foundation for future investigations and identifies possible challenges. Systematic review is a series of processes:

1. identifying the research questions and eligibility criteria while developing protocol,
2. systematically conducting the literature search and screening of articles,
3. assessing and coding articles, and
4. synthesizing results through appropriate methods.[8]

Following this approach, we identified search terms, databases, and eligibility criteria to collect a comprehensive set of relevant studies. The author who is an expert on systematic reviews searched the following data bases: Eric (Ebsco), Academic Search Complete (Ebsco), and Engineering Village (Compendex) using search terms that included discipline (STEM or engineering), race (Latino or Hispanic), and institution focus (transfer or two-year college), as well as synonyms for each. To calibrate screening using the eligibility criteria, four authors jointly screened twenty studies using the title and abstract. After discussions to clarify the eligibility criteria, we assigned the remaining studies to four authors, with two authors screening each article. For the articles identified in the screening process, two authors then read the full text of each article and used the eligibility criteria to determine the articles that would be evaluated for use in the systematic review and sorted the articles by research methodology: quantitative, qualitative, and mixed method. We resolved disagreements between authors through discussion.

The search identified 2732 studies. First, we removed 541 duplicates. Next, we removed 1579 articles based on applying our criteria to the abstracts. This left 612 articles. We evaluated the full text of these articles and removed 442 because two authors each agreed that they did not meet the eligibility criteria. This left 170 articles. We evaluated these articles with respect to the purposes of the systematic review and eliminated 103 articles. The 67 qualifying studies include 42 quantitative, 9 qualitative, and 16 mixed method. Most interventions described in these studies were designed to support Latino students in 2-year institutions or all students enrolled in 2-year designated Hispanic-serving institutions. However, we found a few articles (7) that presented results specifically about STEM Latino transfer students.

Discussion

Based on several decades of attention directed to Latino students in STEM, the increased access to higher education provided by 2-year institutions, and the central role of vertical transfer in attainment of bachelor's degrees for Latino STEM students, we expected to find significantly more than 67 studies, especially more than 7 studies focused on STEM Latino transfer students. However, we found that less than 5% of the 2191 articles initially identified described interventions for student populations of interest. Almost half of these studies centered around vertical transfer while the other half focused on success of Latino students in 2-year institutions. Of the qualifying studies, less than one third addressed transfer of STEM students, and only 7 specifically concentrated on Latino STEM transfer students. As all of our qualifying studies considering transfer students including STEM programs were published after 2010, we recommend future similar reviews do not need to consider studies published before 2010.

Although the overall number of qualifying studies was small, we identified a variety of promising interventions: counseling, academic and career mentoring, internships, research

opportunities, and scholarships. Almost all of the studies that included scholarships as an intervention were funded by the National Science Foundation's Scholarships in STEM program. However, none of these studies considered comparison groups of students who did not receive scholarships, so effects of the scholarship intervention were conflated with other factors. The NSF program did not indicate transfer students as a requirement but "expected that awardee institutions will have or develop support programs and services designed to enhance student learning, confidence, performance, retention to graduation, and career or higher education placement."[9] Mentoring, community-building, career counseling and tutoring are all listed in this solicitation and used widely to service students across disciplines and at 4-year and majority white institutions. As such, it is not surprising that these interventions were identified by the review. We can conclude that interventions focusing on retention, which are studied more widely in 4-year or majority white institutions, seem to be employed with 2-year institution, Latino, and transfer populations with some success.

Although many interventions seemed promising, few of the interventions were supported by repeated studies using the same criteria for evaluating efficacy of the intervention. Also, it was difficult to collect evidence that supported a specific intervention because many studies used multiple interventions concurrently. Many of the 67 studies used multiple interventions that potentially interacted.[10] Many studies, for example, provided counseling and mentoring combined with academic supports, such as tutoring. Rarely though, were the interactions between components or the relative efficacy of each intervention considered. More often the program was evaluated as a whole. Therefore, the evidence gathered in this review does not provide compelling proof of efficacy for any single intervention in the context of Latino STEM transfer students. We concluded there are not enough primary studies to consider complex relationships between components. While future studies could describe the complexity of these multifaceted interventions, we are currently limited to characterizing interventions.

In this systematic review, we anticipated finding studies addressing well documented challenges of students at 2-year institutions such as credit transfer, remedial math courses, and course placement methods. In addition to these, we included interventions not related to STEM content, because success of Latino students in 2-year institutions and transfer to 4-year institutions depends on other factors. The interventions addressed family support, financial responsibility, English course placement, English as a Second Language, and immigration and citizenship. Interventions included learning communities, English course-based interventions, interventions to encourage social interaction, engagement with faculty, and workshops on financial aid. We believe the future work of supporting Latino STEM transfer students' success involves addressing these issues extending beyond STEM content.

Conclusions

The important role 2-year institutions play in efforts to increase diversity among STEM graduates is echoed in numerous papers and national reports. While the challenges encountered along this path to a STEM baccalaureate degree are well documented, common interventions used to support these students have not been evaluated systematically. Thus, we conducted this systematic review and generated several findings. The total number of studies designed to support Latino students matriculating at 2-year institutions and supported by evidence of the

efficacy of these programs was surprisingly small. Considering the emphasized importance of 2-year institutions to the population of Latino students and the attention this issue has received over time, we expected to find more studies intended to improve outcomes for Latino students initially enrolling at 2-year institutions and supported by evidence. Also, due to the complex nature of interventions and their application, there is a lack of replication studies to validate the effectiveness of interventions. Although multiple interventions have been implemented, we found no interventions with adequate support to recommend widespread implementation. These shortcomings suggest that building effective interventions and evaluating them rigorously will require collaboration across a wide breadth of stakeholders.

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