Transitioning STEM Learners to Calculus: Findings from a National Survey of Mathematics Chairs in Two-Year Colleges by Hispanic-Serving Institutional Designation

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Despite the documented need for graduates in STEM (science, technology, engineering, and mathematics) fields or with broader STEM competencies, colleges have yet to significantly increase the success of students from historically underrepresented groups in the STEM mathematics pathway (Bressoud, Carlson, Mesa, & Rasmussen, 2013; Griffith, 2010). The sense of urgency is acute because women and racial/ethnic minorities are the fastest growing segments of our workforce (Toossi, 2012). Two-year colleges account for 35.3% of all postsecondary students who major in STEM (NPSAS, 2016a, p. 222). Moreover, nearly a third (31.2%) of community college students enrolled in STEM attend Hispanic-Serving Institutions (HSIs) (NPSAS, 2016b). For mathematics programs in associate-granting institutions to thrive in the future, they must be more successful with diverse students given the country's need for STEM talent, coupled with its changing population demographics.

This article presents findings from a national survey of mathematics department chairs in associate degree-granting colleges conducted by the research team for Transitioning Learners to Calculus in Community Colleges (TLC3) (TLC3 NSF-IUSE #1625918). This analysis focuses on four areas of practice captured in the survey: math placement, course options, student support, and faculty access to local data and professional development on topics related to diversity. These areas were identified based on prior research and a review of the literature conducted by members of the TLC3 research team as influencing student transition into, and through, courses in the STEM mathematics pathway from developmental mathematics to precalculus to calculus I or II (henceforth, "DPC2") (Palmer & Wood, 2013; Burn, Mesa, & White, 2015).

The findings of this study are disaggregated to compare practices employed at HSIs and nonHSIs. Colleges and universities designated as HSIs have full-time equivalent enrollment (FTE) comprising 25% or more Latinx students and collectively enroll 62% of the nation's Latinx students. Forty-four per-

[1] Historically, "Hispanic" refers to countries formerly colonized by Spain or Spanish-speaking countries. In contrast, the term "Latinx" is preferable in being more inclusive than "Hispanic/Latino" and more gender neutral than "Latina/o."

cent of HSIs are two-year colleges (HACU, 2017). Nearly a third (31.2%) of community college students enrolled in STEM attend HSIs (NPSAS, 2016b). Thus, HSIs play a crucial role in increasing the percentage of Latinx students obtaining STEM degrees. By disaggregating the TLC3 national survey data by HSI designation, this study fills a gap in the literature with respect to research that examines institutional practices in HSIs that affect students in the STEM mathematics pathway.

Relevant Literature

Colleges can have different or even multiple minority-serving institutional (MSI) designations depending on the student subpopulations they serve. MSI designations include Asian American, Native American, and Pacific Islander Serving Institutions (AANAPISIs), Predominately Black Institutions (PBIs), Historically Black Colleges and Universities (HBCUs), Hispanic-Serving Institutions (HSIs), and Tribal Colleges and Universities (TCUs). HSIs educate the majority (62%) of Latinx students in the nation and are concentrated in the states of California, Texas, Florida, New York, and Illinois (HACU, 2017). Research is unclear about what the HSI designation means in terms of differences in institutional practice. In fact, a number of scholars and practitioners have been critical of the HSI designation, noting that HSIs often fail to serve Latinx students in ways that distinguish them from other students (Gasman, Baez, & Turner, 2008). This has led to a common refrain that "HSIs are Hispanic enrolling, not Hispanic serving."

Latinx and other Underrepresented Minority (URM) students in STEM often do not have persistence and completion outcomes that are on par with that of their peers (Wood & Palmer, 2014). One challenge is that nearly 50% of community college students, regardless of racial/ethnic affiliation, are required to engage in developmental mathematics and never reach college-level mathematics courses (Cullinane & Treisman, 2010; Gasman & Nguyen, 2014). In California, home to the largest community college system in the nation (114 colleges), the completion rate for developmental mathematics is 36.5% overall, a low completion percentage that is a function of low pass rates for individual courses at 53%. However, this pass rate only increases to 56% for college-level courses (CCCCO, 2018). Thus, increasing STEM student success in the two-year context requires a broad focus on courses, including developmental math, as well as institutional policies and practices around mathematics placement (Cullinane & Treisman, 2010; Melguizo, Kosiewicz, Prather, & Bos, 2014).

Comprehensive support systems (e.g., culturally responsive environments with strategic approaches to meeting personal and academic learning needs) increase the success rates of racial minority students in STEM (Harper, 2010, 2012; Palmer & Woods, 2013). These findings align with research on calculus in two-year colleges that showed program success was associated with multiple factors, including high-quality instruction, effective placement, out-of-class academic support including arranging study groups, and program improvement efforts (Burn et al., 2015). Improving student outcomes also requires institutional support for sustained faculty professional development (Henderson, Beach, & Finkelstein, 2011) and access to student outcomes data. Disaggregating outcomes data by student demographics is essential to revealing inequalities that may otherwise remain hidden (Harris III & Bensimon, 2007).

Methods

The TLC3 national survey was sent to mathematics chairs or their designees at the nation's 1,023 associate degree-granting institutions identified through the Integrated Postsecondary Education Data Set (IPEDS) (Institute of Education Sciences, 2018). The national survey was open from March to September of 2017 and was recast twice to nonresponders. In total, 500

[2] The TLC3 National Survey was cast to public two- and four-year colleges that primarily award associate degrees.

[3] For information about and current listings of MSI institutions, see https://www2.ed.gov/about/offices/list/ope/idues/eligibility.html#el-inst. Among public 2-year colleges (n = 958), the 2017 MSI grantees included 85 HSIs, 18 TCUs, 11 HBCUs, 28 PBIs, 13 AANAPISIs.

respondents from 453 unique campus sites completed the survey for a 44% response rate (453/1023). During data cleaning, 19 responses (4%) were deleted because of substantial missing data or because of duplicate responses. For duplicate responses from the same individual, we examined both responses and kept the most complete or recent response. In cases of duplicate responses from a single campus (n = 45), we kept the response from the person identified as either the mathematics chair or dean of science and mathematics. Survey respondents from colleges in multi-campus institutions (n = 11) were counted as unique campus sites. For each college represented in the sample, we added IPEDS data, including institutional characteristics, enrollment and graduation rates, and student demographics.

The final sample was representative of the nation's community colleges in terms of location, urbanicity, size, and setting. Specifically, 49 states were represented in the sample (all but Nevada), and the distribution of respondents by state was within three percentage points of the national distribution. Further, the sample was within three percentage points of the national distribution in terms of urbanicity (city, suburb, town, rural) and within five percentage points of the national distribution in terms of size and setting. Large, suburban campuses were the most overrepresented (15% nationally, 18% of sample), and remote towns were the most underrepresented (11% nationally, 9% of sample).

In the final sample, 259 colleges (57%) were MSIs based on enrollment data from IPEDS, including 108 (24%) HSIs representing 13 states. To make clean comparisons between HSIs and nonHSIs, we omitted 56 (12%) colleges identified as "Emerging HSIs" with FTE enrollment comprising 15.0 to 24.9% Latinx students (HACU, 2017). Thus, there were 289 nonHSIs included in the analysis. It is noteworthy that the nonHSI group in this analysis included 28 colleges with other MSI designations (5 HBCUs, 10 PBIs, 7 TCUs, and 6 AANAPISIs). Chi-square tests of independence were conducted to examine the relationship, if any, between specific practices and HSI designation.

A limitation of this study is that it did not control for the existence of state-level policies that may be influencing institutional practice. The largest number of HSIs in the sample were in California (n = 38) and Texas (n = 23) where state-level policies have been enacted around mathematics placement and developmental mathematics. A further consideration is that HSIs in the sample tended to be larger than nonHSIs. Specifically, 25% of the HSIs had student enrollments of 20,000 or more, and 32% had enrollments between 10,000 and 19,999 compared to 4% and 10%, respectively, of nonHSIs. Lastly, a higher proportion of HSIs than nonHSIs in the sample were located in cities (HSI 53%; nonHSI 30%) and suburbs (HSI 30%, nonHSI 17%). These differences limit our ability to make assumptions or draw conclusions about what might be driving any differences in practice by HSI designation.

Findings

The order of the presentation of findings parallels the student experience as they transition into, and through, the DPC2 sequence, beginning with mathematics placement, followed by DPC2 course options, and practices around student support. The final set of findings focus on institutional support around faculty access to local data and professional development on topics related to diversity. For ease of reading, we report test statistics and p values in the tables of findings but omit them from the text, and we refer to the mathematics chairs who responded to the TLC3 national survey as "survey respondents."

Mathematics Placement

Accurately placing students into their initial mathematics course is essential to supporting equitable outcomes in the DPC2 sequence. Table 1 shows mathematics placement practices by HSI status and reveals that HSIs (40%) and nonHSIs (36%) in the sample were comparable in the proportion that used high-school GPA or mathematics course grades as a placement measure. However, in other placement practices, the proportions were not comparable.

Table 1

Mathematics Placement Practices by HSI Designation

	HSI (n = 108)	NonHSI (n = 289)	χ^2
Multiple placement measures used[a]	72%	62%	3.92*
High school GPA or mathematics grades used	40%	36%	0.44
AP courses used	26%	10%	15.23***
Test-out options for all DPC2 courses	62%	43%	11.11***

Notes. [a]Survey options included placement test, high-school measures, advising, self-placement, or "other."
*$p < .05$; ** $p < .01$, ***$p < .001$

Table 1 shows that HSIs (72%) more frequently accepted more than one placement measure (e.g., placement test or high school mathematics grades) than nonHSIs (62%) and more frequently accepted Advanced Placement (AP) scores for placement (HSI 26%, nonHSI 10%). In addition, HSIs (62%) more often than nonHSIs (43%) reported having test-out options for all DPC2 courses.

DPC2 Course Options

Offering course options in the DPC2 sequence accommodates learners with diverse preparation and learning preferences. For STEM-interested students, options that enable students to accelerate to calculus are desirable. Table 2 shows DPC2 course options by HSI designation.

Table 2

DPC2 Course Options by HSI Designation

	HSI (n = 108)	NonHSI (n = 289)	χ^2
Stand-alone Calculus I, II	99%	97%	NA
Honors Calculus	23%	7%	21.35***
Precalculus acceleration options[a]	18%	14%	0.71
Developmental course options:			
Traditional lecture courses	91%	73%	14.33***
Differentiated pathways for STEM and nonSTEM	63%	38%	19.15***
Compressed courses[b]	62%	41%	13.74***
Modularized or emporium model	28%	42%	6.32*
Corequisite model[c]	27%	19%	3.17*
Learning communities[d]	20%	9%	14.33***

Notes. [a]Precalculus refers to any transfer-level college mathematics course above the level of intermediate algebra that students may be required to take prior to their initial calculus course (e.g., trigonometry, precalculus I, and college algebra). Colleges identified as having "acceleration options" offered both stand-alone and combination courses, such as college algebra, trigonometry, and combined college algebra and trigonometry.

bE.g., the option to complete a 16-week course in 8 weeks.
cE.g., students coenroll in intermediate algebra and college algebra.
dE.g., students coenroll in a developmental mathematics and writing course.
*$p < .05$; ** $p < .01$, ***$p < .001$

The analysis of course options at the calculus level revealed that most survey respondents offer only stand-alone calculus I and II (HSI 99%, nonHSI 97%). The only notable course option at this level was Honors Calculus, which HSIs (23%) offered more frequently than nonHSIs (7%). At the precalculus level, overall 15% (n = 60) of survey respondents indicated they offered students the option to accelerate through precalculus by offering combined courses in addition to stand-alone courses (e.g., college algebra, trigonometry, and combined college algebra and trigonometry), and the proportions by HSI status were comparable.

There was much more variety in course modality at the developmental level and important differences in frequency of offerings. Overall, HSIs (91%) offered the option of traditional lecture courses more frequently than nonHSIs (73%) and less frequently used the emporium model (HSI 28%, nonHSI 42%). Directly relevant to STEM majors, more HSIs (63%) than nonHSIs (38%) offered differentiated pathways through developmental mathematics for STEM and nonSTEM majors, compressed courses (HSI 62%, nonHSI 41%), corequisite models (HSI 27%; nonHSI 19%), and learning communities (HSI 20%, nonHSI 9%).

Student Support

Historically underserved students benefit from culturally congruent social and academic support that encourages positive peer and faculty interactions. Table 3 shows selected survey items associated with student support.

Overall, the proportion of survey respondents having a mathematics lab or tutoring center, online tutoring, programs to support URM students in STEM, and space for students to gather informally to work on assignments and/or socialize was similar across HSI designation. However, more HSIs than nonHSIs offered supplemental instruction (HSI 69%; nonHSI 45%) or peer tutoring (HSI 51%, nonHSI 32%) in at least some DPC2 courses. It is also notable that more HSIs (53%) than nonHSIs (29%) had mathematics clubs or competitions for stu-

Table 3
Student Support in DPC2 by HSI Designation

	HSI (n = 108)	NonHSI (n = 289)	χ^2
Support for Mathematics Learning			
Math lab or tutoring center[a]	72%	74%	0.29
Online tutoring[a]	50%	48%	0.11
Supplemental instruction[b]	69%	45%	17.19***
Peer tutoring[b]	51%	32%	11.80**
Additional Supports			
Early alert/warning system[a]	61%	72%	3.95*
Programs for URM in STEM	53%	52%	0.53
Space for students to work[c]	75%	69%	1.25
Math clubs/competitions for precalculus and calculus	53%	29%	19.33***

Notes.
[a]Available for all DPC2 courses.
[b]Available for some DPC2 courses.
[c]Space on campus for students to informally gather to work on assignments and/or socialize.
*$p < .05$; ** $p < .01$, ***$p < .001$

dents at the precalculus and calculus level. Finally, the analysis revealed that fewer HSIs (61%) had early alert or early warning systems in place in all DPC2 courses relative to nonHSIs (72%).

Institutional Support

Table 4 shows the extent to which survey respondents reported that their institution provides faculty with access to local data, whether that data is disaggregated by race/ethnicity or gender, whether their campus offers faculty professional development around topics related to diversity, and whether faculty development for part-time faculty is required or strongly recommended.

Overall, regardless of HSI designation, similar proportions of survey respondents reported having access to data. In the aggregate, 44% (n = 201) of survey respondents indicated their program had access to readily available data to help inform decisions about their mathematics program. An additional 49% (n = 222) had access to data that were not readily available. There were, however, different proportions by HSI designation. For example, more HSIs (59%) than nonHSIs (39%) disaggregated the data by student demographics, including disaggregating by race/ethnicity (HSI 34%, nonHSI 10%), or by both race/ethnicity and gender (HSI 29%, nonHSI 8%). In addition, a higher percentage of HSIs (69%) than nonHSIs (49%) indicated their campus offered professional development around topics related to diversity, such as microaggressions, implicit bias, culturally responsive teaching, validating practices, or relationship building. Lastly, as shown in Table 4, 58% of HSIs reported requiring or strongly recommending professional development for their part-time faculty compared to a significantly lower 43% of nonHSIs.

Table 4
Institutional Support for Student Data and Professional Development by HSI Designation

	HSI (n = 107)	NonHSI (n = 288)	χ^2
College provides access to data			
Yes, readily available	44%	44%	0.01
Yes, not readily available	53%	48%	0.05
Data disaggregated at all	59%	39%	12.18***
Disaggregated by race/ethnicity	34%	10%	31.54***
Disaggregated by race/ethnicity and gender	29%	8%	27.73***
Diversity training offered[a]	69%	49%	12.41***
Part-time faculty development required or strongly recommended	58%	43%	7.12**

Notes.
[a]College offers PD on at least one of the following: microaggressions, implicit bias, culturally responsive teaching, validating practices, or relationship building
*$p < .05$; ** $p < .01$, ***$p < .001$

Discussion

The findings in this article, drawn from a large and representative sample of mathematics programs in associate degree-granting institutions, suggest that there are more progressive practices taking place at HSIs than what was reported at other institutions. Specifically, the study found that HSIs more often than nonHSIs accepted more than one placement measure, used AP scores for placement, and allowed students to test out of all DPC2 courses. At the developmental mathematics level, students at HSIs more often had access to differentiated pathways for STEM and non-STEM students and compressed courses compared to nonHSIs. At the same time, HSIs offered more traditional lecture courses and fewer modularized or emporium model courses than nonHSIs at the developmental level. Furthermore, the analysis suggests that HSIs are "leaning in" on diversity by disaggregating data, training their personnel to better engage diverse populations, and providing more student support, in addition to traditional tutoring, such as peer tutoring, supplemental instruction, and mathematics clubs and competitions in precalculus and calculus.

Implications for Practice

Improving student transition into, and through, DPC2 requires a constellation of connected efforts informed by data. For instance, accurately placing students into their initial mathematics course and providing them with course options through developmental math are twin efforts that combine to impact student success. Ongoing, continuous improvement efforts in both areas need to be driven by student outcomes data. In this study, less than half of the TLC3 survey respondents indicated they had readily available access to local data. Furthermore, although HSIs more often than nonHSIs reported disaggregating their data by student demographics, less than a third (29%) of HSIs reported disaggregating data by race/ethnicity and gender. Regularly examining disaggregated student outcomes data and transforming that data into actionable knowledge is an essential practice for mathematics programs committed to closing the equity gap (Harris III & Bensimon, 2007; Wood, Harris III, & White, 2015). Disaggregating data identifies students who are performing at a level below that of their peers, which then provides opportunities to develop interventions that disproportionately impact those groups[4].

Next, the findings revealed notably fewer course options at the precalculus or calculus levels in either HSIs or nonHSIs compared to the developmental level. This is despite calls from professional associations and disciplinary partners to modernize the STEM mathematics pathway (Saxe & Braddy, 2015; Rotman, 2018). Rethinking the learning outcomes in precalculus and calculus and ensuring that the former provides adequate preparation for the latter, is good for all students. However, there may be enhanced effects for URM students given research suggesting the role of motivation and relevance for students who are perceived as outside the mainstream mathematics culture (Wood et al., 2015). Because precalculus and calculus courses are more often subject to concerns over course transfer, redesigning the STEM math pathway is best approached through collaborations with transfer institutions or state-level redesign efforts (Burn, 2012).

This study documented the numerous forms of support mathematics programs offer their students. The study also revealed that a high proportion of mathematics faculty in associate degree-granting colleges have access to professional development on topics related to diversity (HSI 69%, nonHSI 49%). The connection between student support and professional development is important to highlight. Specifically, research documents the positive effects of student engagement with instructors and other students, as well as student participation in the support mechanisms provided by the department. These findings are consistent with Tinto's model of student retention being a consequence of academic and social integration (Kuh, 2008; Tinto, 1975, 2000, 2012). However, meaningful engagement and positive educational outcomes across diverse student groups require culturally responsive academic and social integration (Denson & Chang, 2009; Wasley, 2006). This study found that most campuses provide space on campus for students to informally gather to work on assignments and/or socialize (HSI 79%; nonHSI 65%). Such spaces afford opportunities for mathematics faculty to engage and interact with students. The quality of these interactions can be enhanced through sustained professional development that teaches mathematics faculty members the theoretical foundations and practices of engagement needed with diverse student populations (Bensimon, 2009; Henderson et al., 2011). Professional development of this kind is essential given the demographics of two-year college mathematics faculty. Specifically, 77% of permanent full-time faculty and 78% of part-time faculty identify as White (nonHispanic), and 67% of mathematics faculty are part-time (Blair, Kirkman, & Maxwell, 2018, p. 188).

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[4]A focus on engaging this process has been embraced by hundreds of colleges nationwide through collaborations with the Community College Equity Assessment Lab at San Diego State University, the Center for Urban Education at University of Southern California, and Project MALES at the University of Texas at Austin.

Implications for Research

During this time of intense pressure for change in the two-year mathematics context, future research on both course redesign and pathway redesign in DPC2 should attend to the interaction between mathematics placement, course redesign, and student support. To advance equity in our field, researchers should focus on how redesign efforts serve specific student subpopulations as opposed to taking a *rising-tide-lifts-all-boats* approach that is unlikely to close achievement gaps. Research is also needed on professional development models for mathematics faculty around equity mindedness and cultural responsiveness, including case studies of programs with documented successful outcomes that included part-time faculty.

Further, given that many URM students receive academic support through campus-wide programs such as TRiO or PUENTE, future research should explore how academic tutoring offered through these programs overlaps or interacts with traditional campus tutoring centers or math labs, where students will need to access support as they transition to higher-level courses in DPC2. Finally, more than two-thirds of the TLC3 national survey respondents indicated having early alert or early warning systems in place, and nonHSIs more often reported using these systems than HSIs. Future research should explore how colleges implement these systems and their benefit to students.

Conclusion

This study focused on four focal areas of the TLC3 National Survey of mathematics chairs in associate degree-granting colleges: placement, courses, student support, and faculty access to data and professional development. The study compared the frequency of practices at HSI and nonHSI institutions and found many progressive practices taking place at HSIs, some of which may be the result of state policy or influenced by other factors not controlled for in this study such as institutional size or location. The next phase of the TLC3 project involves case studies of mathematics programs at minority-serving institutions to learn directly from students, faculty, and staff how their programs, strategies, and practices are culturally congruent and positively contribute to URM students' resiliency and enhance their ability to successfully navigate transitions to reach their academic goal. This next phase includes classroom observations in DPC2 courses to examine instruction that supports mathematics learning, relationship building, and other enhanced practices identified by Wood et al. (2015) that support the success of URM students. The overall goal of the TLC3 project is to develop an institutional self-assessment tool that mathematics programs and their institutions can use to remedy barriers that inhibit student success in DPC2. We invite colleagues interested in improving URM student success in the STEM mathematics pathway to join the TLC3 networked community by signing up at https://occrl.illinois.edu/tlc3.

Lucky Larry

Solve the equation: $3x+2(4x-10)=13$

$$3x+2+4x-10=13$$
$$7x+2-10=13$$
$$7x-8=13$$
$$7x=21$$
$$x=3$$

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References

Bensimon, E. M. (2009). Foreword. In S. R. Harper & S. J. Quaye (Eds.), S*tudent engagement in higher education: Theoretical perspectives and practical approaches for diverse populations* (pp. xxi–xxvi). New York, NY: Routledge.

Blair, R., Kirkman, E. E., & Maxwell, J. W. (2018). *Statistical abstract of undergraduate programs in the mathematical sciences in the United States: Fall 2015 CBMS survey.* Providence, RI: American Mathematical Society.

Bressoud, D. M., Carlson, M. P., Mesa, V., & Rasmussen, C. (2013). The calculus student: Insights from the Mathematical Association of America national study. *International Journal of Mathematical Education in Science and Technology*, *44*, 685–698. doi: 10.1080/0020739X.2013.798874

Burn, H. E. (2012). Factors that shape curricular reasoning about college algebra reform. *MathAMATYC Educator*, *4*(1), 23–28.

Burn, H. E., Mesa, V., & White, N. (2015). Calculus I in community colleges: Findings from the national CSPCC study. *MathAMATYC Educator, 6*(3), 34–39.

California Community College Chancellor's Office (CCCCO). (2018). Data mart credit course retention and success rate summary for math. Sacramento, CA: California Community Colleges Chancellor's Office. Retrieved from https://datamart.cccco.edu/Outcomes/Course_Ret_Success.aspx

Cullinane, J., & Treisman, P. U. (2010). *Improving developmental mathematics education in community colleges: A prospectus and early progress report on the Statway Initiative*. Paper presented at the National Center for Postsecondary Research Developmental Education Conference, New York, N.Y. Retrieved from National Center for Postsecondary Research website: http://www.postsecondaryresearch.org/past-conferences/2010/downloads/NCPR_Panel4_CullinaneTreismanPaper_Statway.pdf [Also available from ERIC database. (ED533871)]

Denson, N., & Chang, M. J. (2009). Racial diversity matters: The impact of diversity-related student engagement and institutional context. *American Educational Research Journal*, *46*, 322–353. doi: 10.3102/0002831208323278

Gasman, M., Baez, B., & Turner, C. S. V. (Eds.). (2008). Understanding minority-serving institutions. Albany, NY: State University of New York Press.

Gasman, M., & Nguyen, T.-H. (2014). Historically Black colleges and universities (HBCUs): Leading our nation's effort to improve the science, technology, engineering, and mathematics (STEM) pipeline. Texas Education Review, 2(1), 75–89.

Griffith, A. L. (2010). Persistence of women and minorities in STEM field majors: Is it the school that matters? Economics of Education Review, 29, 911–922. doi: 10.1016/j.econedurev.2010.06.010

Harper, S. R. (2010). An anti-deficit achievement framework for research on students of color in STEM. *New Directions for Institutional Research*, 148, 63–74. doi: 10.1002/ir.362

Harper, S. R. (2012). *Black male student success in higher education: A report from the National Black Male College Achievement Study*. Philadelphia, PA: University of Pennsylvania, Center for the Study of Race and Equity in Education.

Harris, F., III., & Bensimon, E. M. (2007). The equity scorecard: A collaborative approach to assess and respond to racial/ethnic disparities in student outcomes. *New Directions for Student Services*, *120,* 77–84. doi: 10.1002/ss.259

Henderson, C., Beach, A., & Finkelstein, N. (2011). Facilitating change in undergraduate STEM instructional practices: An analytic review of the literature. *Journal of Research in Science Teaching*, *48*, 952–984. doi: 10.1002/tea.20439

Hispanic Association of Colleges and Universities (HACU). (2017). *2018 fact sheet: Hispanic higher Education and HSIs*. Retrieved from https://www.hacu.net/hacu/HSI_Fact_Sheet.asp

Institute of Education Sciences: National Center for Education Statistics. (2018). *Integrated Postsecondary Education* [Data set]. Retrieved from https://nces.ed.gov/datatools/

Kuh, G. D. (2008). *High-impact educational practices: What they are, who has access to them, and why they matter*. Washington, DC: American Association of Colleges & Universities.

Melguizo, T., Kosiewicz, H., Prather, G., & Bos, J. (2014). How are community college students assessed and placed in developmental math? Grounding our understanding in reality. Journal of Higher Education, 85, 691–722. doi: 10.1080/00221546.2014.11777345

National Postsecondary Student Aid Study (NPSAS). (2016a). *NPSAS institution sector (4 with multiple) by major field of study with a focus on STEM fields* [Data set]. Washington, DC: National Postsecondary Student Aid Study: 2016 Undergraduates.

National Postsecondary Student Aid Study (NPSAS). (2016b). *Minority Serving Institution indicator by NPSAS institution sector (4 with multiple), for major field of study with a focus on STEM fields (math/computer/sciences/engineering/technologies)* [Data set]. Washington, DC: National Postsecondary Student Aid Study.

Palmer, R. T., & Wood, J. L. (Eds.). (2013). *Community colleges and STEM: Examining underrepresented racial and ethnic minorities*. New York, NY: Routledge.

Rotman, J. (2018, April 3). Past, present, future: Developmental mathematics [Webinar]. In *AMATYC 2018 webinar series*. Retrieved from https://c.ymcdn.com/sites/amatyc.site-ym.com/resource/resmgr/webinars/Past,_Present,_Future_of_Dev.pdf

Saxe, K., & Braddy, L. (2015). *A common vision for undergraduate mathematical sciences programs in 2025.* Washington, DC: Mathematical Association of America.

Tinto, V. (1975). Dropout from higher education: A theoretical synthesis of recent research. *Review of Educational Research*, *45*, 89–125. doi: 10.3102/00346543045001089

Tinto, V. (2000). Linking learning and leaving: Exploring the role of the college classroom in student departure. In J. M. Braxton (Ed.), *Reworking the student departure puzzle* (pp. 81–94). Nashville, TN: Vanderbilt University Press.

Tinto, V. (2012). *Leaving college: Rethinking the causes and cures of student attrition* (2nd ed.). Chicago, IL: University of Chicago Press.

Toossi, M. (2012). Labor force projections to 2020: A more slowly growing workforce. *Monthly Labor Review*, *135*(1), 43–64.

Wasley, P. (2006). Underrepresented students benefit most from 'engagement.' *Chronicle of Higher Education*, *53*(13), A39–A40.

Wood, J. L., Harris, F., III., & White, K. (2015). *Teaching men of color in the community college: A guidebook.* San Diego, CA: Montezuma Publishing.

Wood, J. L., & Palmer, R. T. (Eds.). (2014). STEM models of success: Programs, policies, and practices in the community college. In M. C. Brown II. & T. E. Dancy II. (Series Eds.), Contemporary perspectives in race and ethnic relations: Vol. 4. Charlotte, NC: Information Age Publishing.