

Promoting Achievement for Community College STEM Students through Equity-Minded Practices

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ABSTRACT

Community colleges have an opportunity to promote achievement of more science, technology, engineering, and mathematics (STEM) students and meet larger goals of scientific advancement and educational equity. Understanding community college students' needs and backgrounds is key to increasing students' success in STEM fields and realizing this potential. The objective of this paper is to use data from the U.S. Department of Education's National Center for Education Statistics and other sources to characterize community college students and their academic achievement and to offer equity-based approaches to increase success, particularly in STEM. Here, I document that community college students, who constitute approximately one-third of U.S. undergraduates, are a unique population with greater proportions of underrepresented STEM minorities, parents, and students requiring developmental education. They are also more likely to be older, working, part-time, low-income, and first-generation students and more likely to differ demographically from faculty. I also found lower rates of academic achievement among community college students, including lower rates of retention and STEM degree attainment with evidence of even lower achievement for STEM underrepresented groups. The data point to the need for equity-based strategies to address achievement disparities for STEM community college students, including increasing community college faculty diversity and sensitivity to diverse students' needs and experiences; adopting inclusive, active-learning pedagogies; and reforming developmental education.

INTRODUCTION

The U.S. system of higher education has been challenged to produce one million more STEM graduates to maintain the social and economic benefits associated with a healthy science, technology, engineering, and mathematics (STEM) workforce (President's Council of Advisors on Science and Technology, 2012). In addition, we are being asked to increase diversity in STEM (National Academies of Science, Engineering, and Medicine, 2011). Yet, despite knowing that a diverse STEM workforce is key to helping us discover, innovate, and problem solve (Asai, 2020a), we continue to see certain demographic groups such as Blacks or African Americans, Hispanics, and Native Americans or Alaskan Natives underrepresented in the STEM workforce (National Science Board, National Science Foundation, 2020). Community colleges, or 2-year public colleges, could help meet these goals. However, some authors contend that the potential for community colleges to increase diversity in STEM has been largely unrealized (Bahr *et al.*, 2017), as community college students show low STEM degree achievement rates (National Research Council [NRC], 2012a; Wang 2015).

Much of the potential for community colleges to increase diversity in STEM and meet larger goals of educational equity arises because we serve diverse students. While many 4-year institutions have academic admissions criteria, community colleges typically have open admissions. Therefore, these institutions enroll students with wider ranges of prior academic preparation and achievement (Hagedorn and DuBray, 2010). The comparably low cost of community colleges, less than half as much as local

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4-year public institutions and 12.5% the cost of 4-year private institutions (Ginder *et al.*, 2018), makes them accessible to students with lower incomes.

Community college students are also diverse in their educational goals. Even within the relatively narrow confines of a community college biology department, I serve students fulfilling their science general education requirements, completing prerequisites for diverse allied health programs, lifelong learners, and transfer students, as well as biology and other STEM majors pursuing associate's degrees.

Given the diversity of community college students and their goals, equity-based practices may help increase their success in general and in STEM. Whereas equality in education involves treating all students the same, regardless of their needs, equity requires knowing our students and ensuring each one has the tools to be successful (Sims *et al.*, 2020).

However, despite the fact that community college students are approximately one-third of all U.S. undergraduates (National Center for Education Statistics [NCES], 2019a), there is scant discipline-based education research focused specifically on community colleges (Fletcher and Carter, 2010; Schinske *et al.*, 2017). Explanations for limited discipline-based education research from community college faculty members include high faculty teaching loads, limited incentive and institutional support for research, and the lack of institutional review boards at many community colleges (Schinske *et al.*, 2017; Pape-Lindstrom *et al.* 2018). The result is that we have fewer insights from our colleagues about our students and often see generalizations about U.S. STEM undergraduates based on research from 4-year institutions that does not consider the uniqueness of community college students.

The purpose of this paper is to characterize community college students and offer equity-based approaches to help them succeed, particularly in STEM. To do so, my first goal is to characterize current community college students using published and publicly available data from the U.S. Department of Education's National Center for Education Statistics. My second goal is to describe achievement differences that exist for community college students versus those from 4-year institutions, with emphasis on STEM success. Finally, I will use these analyses as foundations for a discussion about equity-based strategies to increase community college STEM student success.

Comparing Community College Students with Other Undergraduates and Faculty Members

In Fall of 2018, 2-year public college students represented a large portion, 33.4%, of all U.S. undergraduate students (NCES, 2019a). Overall, 45.2% of U.S. undergraduates were attending 4-year public institutions, and 20.2% were attending 4-year private institutions. A small portion of U.S. undergraduate students were attending for-profit and 2-year private, nonprofit colleges (5.7%); thus, my analyses do not include data from these institutions.

In Fall of 2018, fewer U.S. undergraduate students were males compared with females (NCES, 2019a), with similar percentages of males and females attending community colleges (Figure 1). At the same time, a lower percentage of white students, 47.9%, attended 2-year public institutions, while 4-year public and private institutions enrolled an average of 56.8% white students. There were higher percentages of Black or

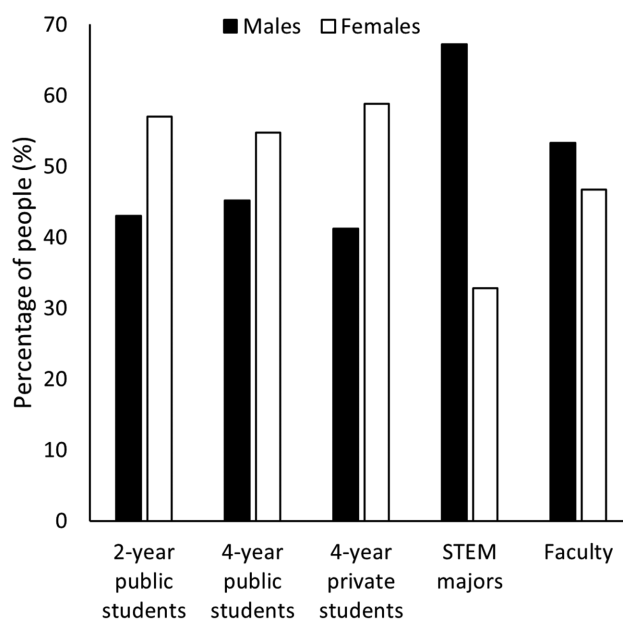


FIGURE 1. Percentages of male vs. female undergraduate students at 2-year public, 4-year public, and 4-year private, nonprofit U.S. institutions in Fall of 2018 (National Center for Education Statistics, 2019a); U.S. undergraduate students majoring in STEM in Fall of 2016 (National Center for Education Statistics, 2016); and all U.S. full-time faculty in Fall 2018 (National Center for Education Statistics, 2019c).

African-American and Hispanic students at 2-year public colleges; 13.4% and 26.2%, respectively, than at 4-year institutions, where 11.5% of students were Black or African American and 15.5% were Hispanic. There were similar percentages of Asian students and students with two or more races or ethnicities, and the percentages of American Indian/Native Alaskan and Pacific Islander students were less than 1% across all types of institutions examined (NCES terms to describe racial/ethnic groups in NCES [2022]) (NCES, 2019b, 2022; Figure 2).

During the Fall of 2018, 68.8% of the faculty in U.S. higher education were white compared with 51.3% of all U.S. undergraduate students (NCES, 2019a,c). Concomitantly, there were lower percentages of Black or African-American and Hispanic faculty members than undergraduate students at all types of institutions examined (Figure 2). The demographic differences were largest between 2-year college students and the U.S. faculty; there were less than half as many Black faculty members as students and less than one-fifth as many Hispanic faculty as students. Furthermore, while there were more female than male students at all types of institutions examined, the U.S. faculty were dominated by males (NCES 2019c; Figure 2).

More specific data from California show similar patterns between student and faculty racial and ethnic diversity at individual community colleges and allow for comparison between more- and less-selective 4-year public institutions. Although individual community colleges vary in their demographics based on the communities they serve, the pattern of larger percentages of white faculty members (60% overall) compared with enrolled white students (39% overall) was seen across all 79 California community colleges examined by Willis and Xie (2021), which

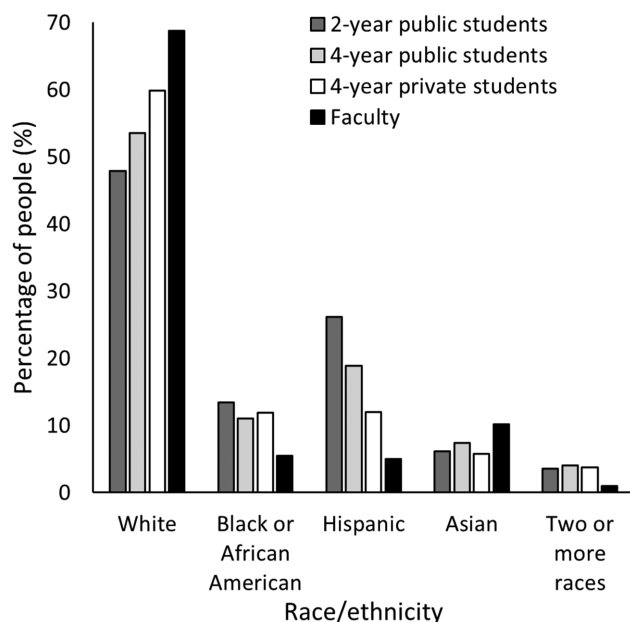


FIGURE 2. Percentage of U.S. undergraduate students attending 2-year public, 4-year public, and 4-year private, nonprofit institutions (National Center for Education Statistics, 2019b) and all U.S. full-time faculty in Fall of 2018 by race/ethnicity (National Center for Education Statistics, 2019c). Percentages of Pacific Islander, American Indian/Native Alaskan students and faculty were all less than 1% and are not shown.

included colleges in urban, suburban, and rural areas. Data from California also indicate that there may be differences in diversity for more- and less-selective 4-year public institutions, although these differences are masked in Figure 2; namely, the less-selective California State universities had racial and ethnic diversities that were more similar to the California community colleges than they were to the University of California institutions (Gordon, 2018).

STEM majors represent 28% and 20% of the students beginning at 4-year and 2-year institutions, respectively. Whereas more U.S. undergraduate students are females, STEM majors attract more than twice as many males as females (Figure 1). In 2016, there were higher percentages of white and Asian students in STEM majors compared with their percentages among all undergraduates, while Black or African-American and Hispanic students were underrepresented in STEM compared with their percentages among all undergraduates (hereafter I will refer to these STEM underrepresented racial and/or ethnic groups as underrepresented minorities, or URM). The averages for other racial and/or ethnic groups in STEM are more similar to the averages for all undergraduates (NCES, 2016).

Many community college students have high levels of responsibility outside school. They are about twice as likely to be independent for financial aid purposes compared with students from 4-year institutions (Campbell and Wescott, 2019). This could be in part because community college students tend to be older. In 2019, 31.4% of community college students were 25 years and older, while around 20% were 25 years and older at 4-year institutions (NCES, 2020b). Additionally, more community college students work more 30 hours per week; 59.1%

compared with an average of 39.4% at 4-year public and private institutions (NCES, 2016) and they are more likely to be parents (Reed *et al.* 2021). The same patterns emerge when examining STEM majors. A survey of biology majors from community colleges, research-intensive institutions, and comprehensive regional 4-year universities found that the community college students were more likely to work for pay, to work more hours on a weekly basis, and to spend more time on family obligations (Freeman *et al.*, 2020). High levels of responsibility outside school likely explain why there are fewer full-time 2-year public college students; 34.6% compared with an average of 77.6% at 4-year institutions (the NCES defines full-time undergraduate students as those taking more 12 units and those taking fewer than 12 units as part-time; NCES, 2020a). The full-time attendance percentages are higher for STEM majors, but the overall pattern is similar; Freeman *et al.* (2020) found that 66.6% of community college biology students were full-time, while this was true of 88.3% of regional, comprehensive university students and 95.9% of research-intensive institution students.

There are also differences in the families and life experiences of students who attend community colleges. In 2016, 65.0% of community college students, but only about 45% of 4-year public and private college students, were first-generation college students (NCES, 2016). More community college students lack college-educated role models in their immediate families. Thus, they may be less familiar with navigating college and may receive less support at home to pursue higher education (Thayer, 2000). Furthermore, more dependent community college students (31.9%) had parents with annual income levels below \$29,700 than students at 4-year public (21.6%) and private (17.6%) institutions (NCES, 2016). Finally, community college students tend to report more traumatic life events, such as discrimination and bullying, than other undergraduates (Anders *et al.*, 2012).

Community college students are also more likely to participate in developmental (also called remedial, basic skills, transitional, or foundational) education programs, which typically involve taking courses in multiple subjects, including math, writing, and reading, that are below college level and intended to increase student preparedness for college-level work (Center for Community College Student Engagement, 2016). While 55.5% of community college students took at least one developmental course in academic year 2015–2016, this was true of about one-quarter of 4-year college and university students (Campbell and Wescott, 2019; Figure 3). Furthermore, the need to take developmental courses was higher among first-generation college students and demographic groups including female and Black or African-American, Hispanic, American Indian/Native Alaskan, and Pacific Islander students (Chen, 2005; Campbell and Wescott, 2019; Figure 3).

Comparing Markers of Success for Community College Students versus Other Undergraduates

There were large disparities in student retention from 2018 to 2019 for part- and full-time students. Despite data indicating grade point averages are similar for part-time and full-time students (Darolia, 2014), retention rates are lower for part-time students across all types of institutions, 47.3% on average (Figure 4). Among full-time students, 81.5% from 4-year institutions were retained, while only 62.5% of community college students returned for a second year (NCES, 2020c). Thus,

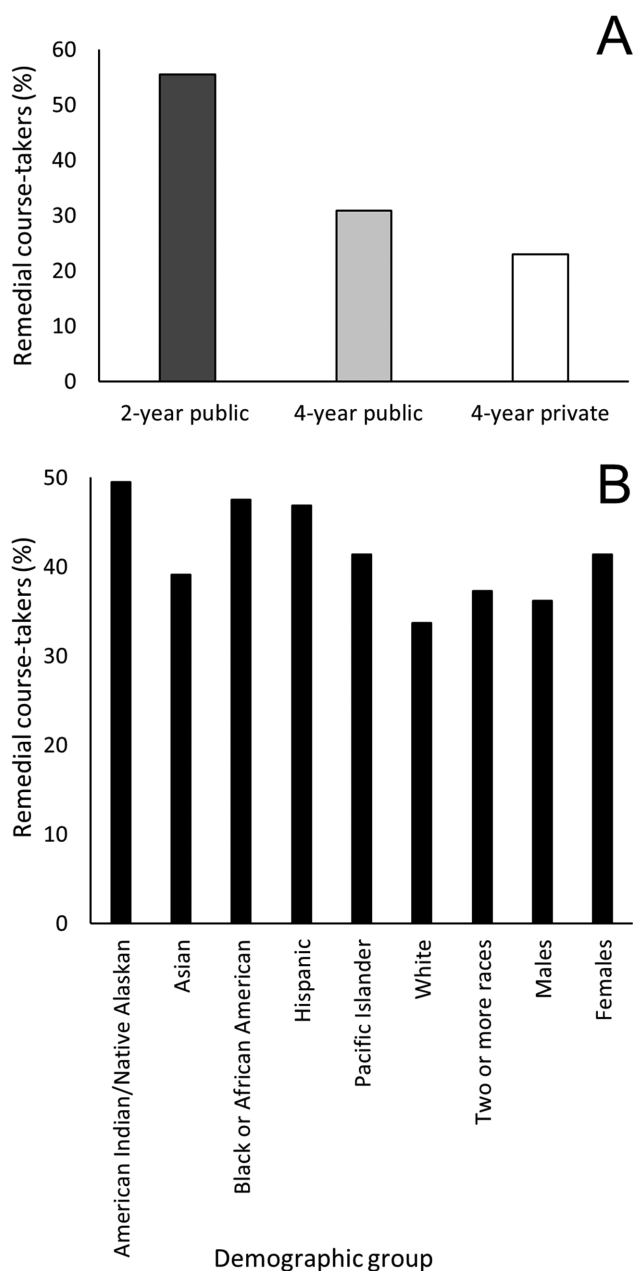


FIGURE 3. Percentage of U.S. undergraduate students taking at least one remedial course at 2-year public, 4-year public, and 4-year private, nonprofit institutions (A) and percentage of all U.S. undergraduate students taking at least one remedial course by race/ethnicity and gender (B) during academic year 2015–2016. Data are from Campbell and Wescott (2019).

strategies to boost retention of all part-time and full-time community college students are crucial.

There are also lower graduation rates for community college students. Graduation rates within 150% of normal completion time (3 years for 2-year college students, 6 years for 4-year institution students) for full-time, first-time, degree-seeking U.S. undergraduate students at 4-year public and private institutions averaged 62.4%, while they were less than half that, 29.9%, for community college students (NCES, 2020a).

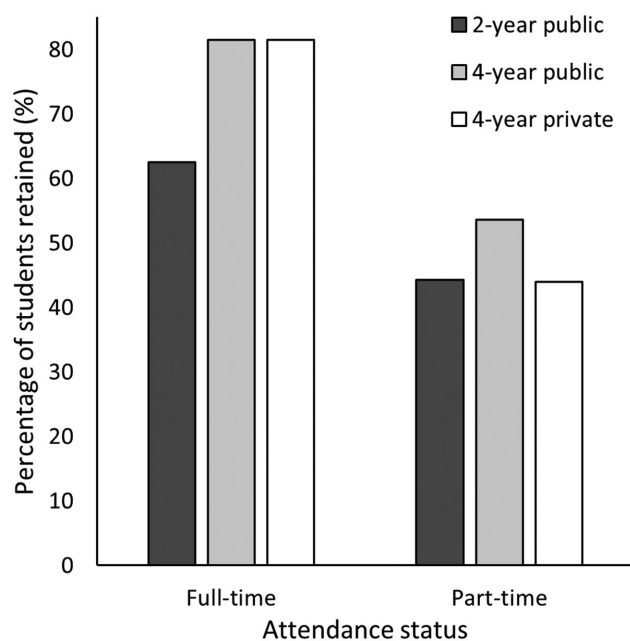


FIGURE 4. Percentage of full-time vs. part-time first-time, degree-seeking 2-year public, 4-year public, and 4-year private, nonprofit U.S. undergraduate students who were retained from Fall 2018 to Fall 2019. Data are from NCES (2020c).

However, graduating with an associate's degree or certificate is not always a goal of 2-year college students. According to Horn and Skomsvold (2011), about 80% of 2-year college students stated that transferring to earn a bachelor's degree or higher was their academic goal. Among these students, between 45% and 50% achieved degree attainment or transfer over 6 years. The Voluntary Framework of Accountability (VFA) score, a measure of success for community college students that includes transfer and achievement of other momentum points, is measured over 9 years, and is also not limited to full-time, degree-seeking students. For the cohort that started in Fall 2010, the VFA was 59% (AACC, 2021). Thus, degree achievement is reduced for 2-year college students when examining the NCES data, but the disparity shrinks when transfer and other measures of success are considered.

While community college males and females had similar percentages of degree attainment (Figure 5), certain demographic groups are less likely to complete associate's degrees or certificates. The graduation rate was 29.9% for all 2-year public college students, white and Asian students had higher graduation rates of 34.1% and 37.6%, respectively, while Black or African American, Hispanic, Native Hawaiian and Pacific Islander, and American Indian/Native Alaskan students had lower than average graduation rates (NCES, 2020a; Figure 5). The same four racial and/or ethnic groups were also awarded lower than average percentages of STEM bachelor's degrees in 2015 (deBrey *et al.*, 2019).

Bachelor's degree attainment is lower for students who begin at community colleges (Monaghan and Attewell, 2015) and even lower for STEM degree attainment. Wang (2015) found that the probability of STEM bachelor's degree attainment was 0.47 for students starting at 4-year institutions and

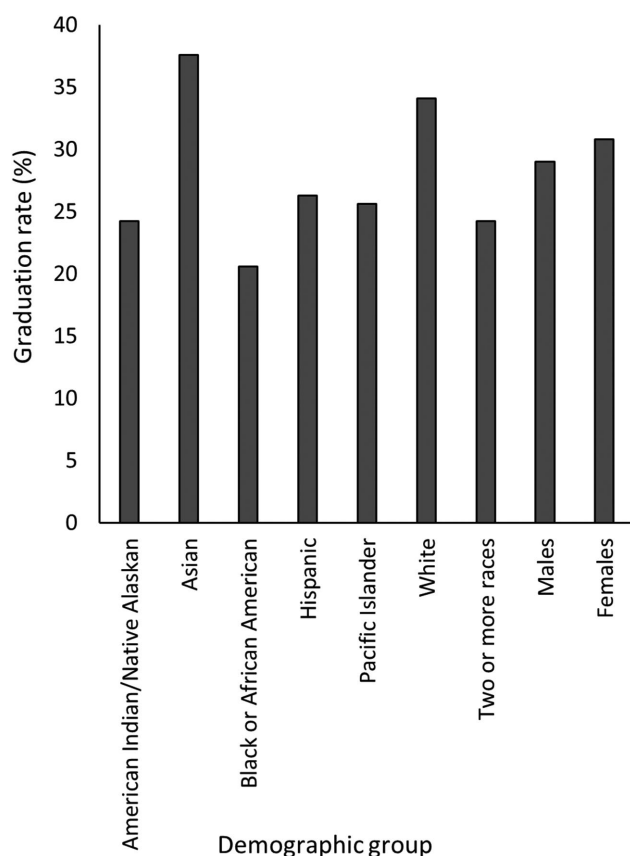


FIGURE 5. Graduation rates within 150% of normal completion time for full-time, first-time, degree-seeking 2-year public college students by race/ethnicity and gender (NCES, 2020a).

0.11 for students starting at 2-year institutions. This may be related to a large portion of STEM majors switching majors before they complete their bachelor's degree. An NRC (2012a) study, which is also described by Labov (2012), used data from a cohort of students who graduated from high school in Ohio in 1999. The data showed that of all high school students who declared an intention to major in STEM, only 43% were still majoring in a STEM field at the time of last enrollment, while this was true of only 12% of the students who attended community college. A more recent study used data from STEM degree-seeking students transferring to a Texas 4-year university from community colleges between 2007 and 2014 and shows slightly higher degree achievement rates; 36.3% of these students earned a STEM bachelor's degree, 12.6% earned a bachelor's degree in a non-STEM discipline, and 51.0% did not earn a bachelor's degree within 6 years of transfer (Zhang, 2021). Thus, STEM bachelor's degree attainment is lower for students who attend community colleges, but slightly higher among those who achieve transfer.

In recent years, a higher percentage of bachelor's degrees have been awarded to females; however, in STEM fields, only 36% of bachelor's degrees were awarded to females. Lower percentages of STEM degree attainment by females were consistent across all racial/ethnic groups (deBrey *et al.*, 2019), because more STEM majors are males, and females, particularly at 2-year colleges, are more likely to leave STEM majors

(Chen, 2013). Biology is an exception to this pattern; every year since 1988, more biology bachelor's degrees have been awarded to females than males (NCES, 2019d).

The general pattern in the achievement data with community college students achieving lower success than other students is a great example of getting what you pay for. Despite data presented here indicating these students need more resources, U.S. community colleges spend 16.3% of the amount spent by 4-year public institutions (Hanson, 2021). According to Kahlenberg (2019), 4-year private research institutions spend \$72,000 per student, 4-year public research institutions spend \$40,000 per student, while community colleges spend \$14,000 per student annually. Inequitable funding needs to be addressed as we strive to achieve equity in education. Many of the strategies and reforms described below will require more funds for community colleges.

EQUITY-BASED STRATEGIES FOR PROMOTING ACHIEVEMENT FOR COMMUNITY COLLEGE STUDENTS **Promote Community College Faculty Diversity and Sensitivity to Diverse Students' Needs and Experiences**

This analysis demonstrated that community colleges enroll more STEM URMs than other U.S. undergraduate institutions. However, reduced graduation rates and STEM degree attainment were detected for URMs and females in STEM. Feelings of being discriminated against by faculty are common for Black or African-American and Hispanic students and more common for females than males (Park *et al.* 2020). Furthermore, discrimination has been negatively associated with STEM retention (Park *et al.*, 2020) and could underlie the reduced success of female and URM students in STEM noted here.

Implicit biases are common and lead to discriminatory behavior. Students may experience discrimination if they do not "fit in" to the dominant conceptions of a scientist's appearance, personal background, and behaviors (Asai, 2020b). For example, most people show a moderate to strong automatic association between males and science fields and females and liberal arts fields (Killpack and Melon, 2016), a bias that could lead to differential treatment of males and females in the STEM classroom and in our advising offices. Additionally, faculty biases about students' innate abilities harm success for URMs; achievement gaps were twice as wide in STEM courses taught by faculty who believed students' academic abilities were fixed (Canning *et al.*, 2019). A second study interviewed STEM professionals and academics about their fields and found that females and URMs were rare in fields whose practitioners and researchers associate success with innate talent or brilliance (Leslie *et al.*, 2015).

Access to ongoing professional development for community college faculty, staff, and leadership to recognize and act on implicit bias, be more inclusive, and increase cultural sensitivity may promote achievement and persistence in STEM for females and URMs. Although time constraints, financial barriers, inequitable access for part-time faculty, and weak institutional support can limit professional development at community colleges (Smith, 2007), many successful models exist (Carnes *et al.* 2012; Parker *et al.*, 2016; Macdonald *et al.*, 2019; O'Leary *et al.* 2020). There are also excellent free resources available (i.e. Dewsbury and Brame, 2019; Sathy and Hogan, 2019; CBE—Life Sciences Education's interactive guide on inclusive teaching;

<https://lse.ascb.org/evidence-based-teaching-guides/inclusive-teaching/>.

U.S. community colleges tend to have greater racial and ethnic diversity among students than faculty (Gordon, 2018; Willis and Xie, 2021; Figure 2). Increasing community college faculty diversity could benefit URM students. Underrepresented minority students often seek mentorship and advice from faculty who are also from underrepresented groups (Griffin *et al.* 2010). These students may view URM faculty as role models, advisors who understand their experiences, and evidence that success in higher education is possible for them (Griffin *et al.*, 2010). Furthermore, URM community college students are more likely to pass a class, more likely to earn a grade of “B” or higher, and less likely to drop a class that is taught by a URM faculty member (Fairlie *et al.*, 2014). Other studies have linked greater likelihood of Black or African-American student persistence in STEM with having at least one course taught by a Black or African-American faculty member (Price, 2010). Interestingly, some studies have found that a high percentage of female STEM faculty members is not associated with higher female STEM student retention (Griffith, 2010; Price, 2010). Thus, other strategies may be more useful for facilitating STEM success of female students.

Though increasing faculty diversity may not be possible in the short term for many community college science departments, all faculty can create a more inclusive classroom by highlighting important work of individuals from groups who are underrepresented in STEM (Tanner, 2013; Killpack and Melon, 2016). Schinske *et al.* (2016) explain how they achieved this through “Scientist Spotlights” homework assignments that shifted student descriptions of scientists to counterstereotypical descriptions while also increasing students’ relatability to scientists, their interest in science, and course grades. A similar study involving “Scientist Spotlights” activities found that positive impacts on confidence were particularly notable for females (Yonas *et al.* 2020). For community college educators, the list of scientists in the spotlight should include some who started their undergraduate careers at community colleges (such as Craig Ventner, who led the private effort to produce the first draft sequence of the human genome).

Hiring diverse faculty members and promoting cultural sensitivity could also reduce stereotype threat (Steele, 1997), a phenomenon that has been associated with lower achievement for URMs (Killpack and Melon, 2016). Stereotype threat occurs when people feel pressure to avoid fulfilling negative stereotypes about their demographic groups or fear they will be evaluated negatively based on these stereotypes. This has been shown to trigger lower test-taking performance (Steele and Aronson, 1995) and hinder learning for URMs (Taylor and Walton, 2011). Some evidence indicates that stereotype threat can be diminished when the test proctor is from the same underrepresented group (Marx and Goff, 2005) and based on how the assessment is introduced (Steele and Aronson, 1995; Taylor and Walton, 2011). For example, proctors may be able to avoid undesirable effects of stereotype threat by making it clear to students that assessments are not meant to measure their fixed intelligence, avoiding verbal or written instructions that cause students to associate their score with their underrepresented groups, or conducting a values affirmation before an assessment (for more information on the benefits of values affirma-

tion for STEM URMs and first-generation college students, see Harackiewicz *et al.*, 2014, 2016; Jordt *et al.*, 2017).

Use Inclusive, Active-Learning Approaches

Active learning is a promising alternative to teaching passively through lectures (NRC, 2012b). It encourages students to produce thoughts and get feedback in interactive settings involving a variety of methods to enhance or replace lecture time, including the use of in-class methods such as student response clickers, think-pair-share activities, group work, writing activities, data analysis and problem-solving activities, mini-labs, and interactive demonstrations (NRC, 2012b). A meta-analysis comparing student achievement in courses that included active-learning elements versus those that did not found significant improvements in exam scores and 1.5 times less failure in courses that involved active learning (Freeman *et al.*, 2014). STEM course grades are a strong predictor of student persistence and success in STEM (Chen, 2013; Wang, 2015), but benefits of active learning expand beyond the course level. Community college STEM students who engage in active learning in introductory courses have shown higher subsequent course grades within the discipline, (Riedl *et al.* 2021), higher 3-year graduation rates (Riedl *et al.* 2021), and higher transfer rates and transfer self-efficacy (Wang *et al.*, 2017), indicating that this practice has learning and psychological benefits for students.

Given the high percentages of URM students attending community colleges and the low rates of STEM degree attainment by URM as well as female students, active learning may be a particularly useful approach in community college STEM courses. A meta-analysis of 41 studies found that active learning reduced achievement differences between URM and other students, including narrowing the gaps in course pass rates by 45% and exam scores by 33% (Theobald *et al.*, 2020). In this study, the amount of class time an instructor devoted to active learning positively impacted student achievement and had disproportionately high impacts for URMs. Other studies examining impacts of active learning on URM student achievement in STEM classes have found that URM community college students who have had courses involving active learning also had higher success in subsequent courses (Burke *et al.*, 2020), that active learning can eliminate differences in final grade differences between URM and other students (Ballen *et al.*, 2018), and that active learning can increase self-efficacy and confidence in URM students (Ballen *et al.*, 2018). Finally, lecture-based approaches are associated with higher dropout rates for female STEM students, who tend to strongly prefer (Rainey *et al.*, 2019) and show increased content understanding with active learning (Lorenzo *et al.*, 2006).

Community college students have more competing demands on their time than students at 4-year institutions (Velez *et al.*, 2018; Downing *et al.*, 2020; Freeman *et al.*, 2020). More than one-third of community college students cite balancing work and school as a challenge, and nearly two-thirds report that their work hours do not allow additional time for studying (Porter and Umbach, 2019). Community college students have also expressed anxiety in lecture-based courses because they feel like the instructor does not have time to interact with them in class and they may not have time to stay after to ask questions (Downing *et al.*, 2020). Active-learning strategies may be

useful for community college students with time constraints and may promote an equitable learning environment, as they give students more time to work with and learn the material during class.

Active-learning approaches may benefit two other community college populations: first-generation and underprepared students. According to McMurtie (2019), first-generation college students focus more on reading and memorizing content than using more effective study techniques such as content summarizing and self-quizzing. Active learning, perhaps because it can model effective study strategies during class, has been shown to make STEM students more skilled learners (Freeman *et al.*, 2011) and improve their study habits (Marrs and Novak, 2004). Furthermore, because it involves intensive practice during class and/or a greater amount of structured activities outside class, it can reduce achievement differences between prepared and underprepared students (Freeman *et al.*, 2011; Haak *et al.*, 2011).

Finally, Theobald *et al.* (2020) contend that inclusive teaching should go hand in hand with active learning and that the two are synergistic for diminishing achievement disparities for URM and underprepared STEM students. Inclusive active learning involves ensuring all students are participating in active learning and feeling included in the course experience (for suggestions, see Tanner, 2013). It also involves treating students with respect and dignity, communicating confidence in their abilities, and conveying a genuine interest in their success (Theobald *et al.*, 2020). Additionally, communicating a strong message of success through conscientious effort is a particularly powerful strategy for supporting low-income and first-generation college students (Thayer, 2000). To be even more inclusive, active-learning activities should be designed to help students make connections between the STEM content they are learning and their lives and cultural frameworks (Sims *et al.*, 2020).

Reform Developmental Education

Traditional developmental education may be widening achievement gaps (Bahr, 2010). Developmental education, which can involve placement testing as well as completing multiple developmental courses in multiple subjects before students can take college-level courses, can be confusing, demotivating, and frustrating (Bailey *et al.*, 2010) while also slowing students' academic progress (Bahr *et al.*, 2019). Data presented here and elsewhere indicate that community college students, first-generation college students, URM students, and women are more likely to be advised to take developmental courses (Chen, 2005; Chen, 2013). Data also indicate that remediation, or passing all advised developmental courses, is rarely achieved (less than 30%) and even less common for URM students (Bahr, 2010). Furthermore, taking developmental courses is associated with reduced transfer rates for community college students compared with students who do not enroll in developmental courses (Chen, 2016).

Developmental education may be an even larger barrier to STEM student success. Community college STEM students are more likely to transfer to a 4-year institution if they have more "STEM momentum," a measure that includes the number of STEM courses attempted in the first semester (Wang, 2015). However, taking developmental courses reduces students' STEM momentum, as these students take fewer STEM courses in the first 2 years (Park *et al.*, 2020), perhaps because it can

take them a while to meet STEM course mathematics prerequisites. Likewise, other research has shown that students are more likely to switch from a STEM major if they take fewer STEM courses and require mathematics remediation (Chen, 2013; Cohen and Kelly, 2020). Because only 12.6% of STEM hopeful community college students start at transfer-level mathematics, this is a major barrier to transfer and STEM goal achievement (Hagedorn and DuBray, 2010; Cohen and Kelly, 2020).

Addressing the issue of underprepared community college students will require larger reforms to the U.S. education system, starting at kindergarten (Bahr *et al.*, 2017). However, there are things community college staff, administrators, and faculty can do to ensure we are not creating unnecessary barriers for students in our developmental education programs. Placement test results can suggest developmental courses for students who could pass college-level courses (Scott-Clayton, 2012; Park *et al.*, 2021). Using other kinds of placement data, such as high school performance, can help reduce these errors (Scott-Clayton, 2012; Bahr *et al.*, 2019). Furthermore, data from Davidson Community College show that students are more successful in college-level courses when they are placed into developmental classes using high school transcript data; this type of placement seemed to benefit Black students more than any other racial or ethnic group (Center for Community College Student Engagement, 2016). Making developmental courses optional may also reduce success barriers. Bailey and colleagues (2010) found that 72% of students who ignored advice to take developmental courses and directly enrolled in a college-level course passed that course, while only 27% of those who attempted and completed the recommended developmental courses completed the associated college-level course. Many states have removed requirements for students to take developmental courses (Center for Community College Student Engagement, 2016; Park *et al.*, 2018). In Florida, this change increased the percentages of Black and Hispanic students enrolling in intermediate algebra and narrowed the difference in course pass rates between these groups and white students (Park *et al.*, 2018). Another reform that many colleges have implemented with great success is the "co-requisite" model, wherein students who are placed below college level enroll in the college-level course but are required to take supplementary instruction as a co-requisite (Accelerated Learning Program, 2021; for an overview of the different approaches to mathematics co-requisites, see Vandal, 2014). Other colleges have found increased success with shorter remedial course sequences (Scott-Clayton, 2018). Considering that the average community college student takes three developmental courses (Chen, 2016), shorter sequences may be particularly beneficial to part-time students who could spend several semesters taking developmental courses and are known to be less likely to complete developmental sequences (Bailey *et al.*, 2010). Other successful reforms include new math pathways focused on quantitative reasoning and statistics rather than the traditional pathway (Center for Community College Student Engagement, 2016; Scott-Clayton, 2018). Finally, regardless of the format of the developmental program, strong academic advising plays crucial roles in education planning in general but is even more important for helping underprepared and URM students navigate developmental education (Bahr, 2008).

CONCLUSIONS

Community colleges have an opportunity to promote achievement of more students in STEM and meet general goals of educational equity. Our students are a unique undergraduate population in the United States, with more URMs, as well as more part-time, low-income, underprepared, and first-generation students. Unfortunately, we are hindered by inequitable funding, and our classroom methods and institutional practices do not seem to be working for a large proportion of students. This analysis highlights lower retention and degree attainment rates, both in general and in STEM fields, and achievement gaps in STEM for female and URM students.

Equity-rooted approaches hold promise to meet the diverse needs of community college students. Community college faculty, staff, and administrators need to examine our own biases to ensure that we are creating welcoming environments that promote the success of all of our students. We need to ensure URMs have role models on our campuses and feel supported and confident that they can achieve in general and in STEM. We know active learning is effective. Inclusive, active learning may be even more effective for community college STEM students. Finally, we need to ensure that developmental education programs, which community college students are commonly required to participate in, are helping rather than hindering the success and widening achievement gaps.

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