Evaluating the Representation of Community Colleges in Biology Education Research Publications following a Call to Action

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ABSTRACT

Interest in biology education research (BER) has been growing over the last two decades, yet few BER publications focus on community colleges, which serve a large percentage of the undergraduate student population and a majority of those students who identify with historically underserved groups. In this paper, we define community college biology education research (CC BER) as publications with a community college faculty member as an author, publications with a community college study context or a focus on community college biology teaching and learning, and publications that use community college students as a source of data. We conducted a literature review to quantify how CC BER has progressed since initial calls for broadening participation by recording the number of CC BER publications in seven prominent journals between 2016 and 2020. Our formal analysis of peer-reviewed BER literature indicates that there has been a statistically significant increase in CC BER publications from 3.2% to 5.9% of total BER publications since the last analysis in 2017. We conclude with a discussion of strategies for further broadening of participation in CC BER.

INTRODUCTION

As of the Fall of 2019, 41% of all undergraduate students in the United States were attending community colleges, including the majority of students identifying as Native American (56%) and Hispanic (53%) (American Association of Community Colleges [AACC], 2021). Community colleges enroll 43% of Black students, 38% of Asian/Pacific Islander students, and 29% of first-generation students (defined as those whose parents have no postsecondary educational experiences; AACC, 2005). Additionally, 33% of funding received by community colleges between 2017 and 2018 was from Pell Grants, which demonstrates the exceptional financial need of those enrolled (Association of Community College Trustees, 2022). Community college students are more likely than their 4-year university counterparts to be older returning students and veterans (National Center for Education Statistics, 2009) and to have responsibilities beyond the classroom, such as employment or supporting families (AACC, 2021).

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Since publication of the highly cited *Vision and Change: A Call to Action* (AAAS, 2011), there has been a nationwide push to incorporate active learning and evidence-based pedagogy in undergraduate biology courses (Bonwell and Eison, 1991; Walker *et al.*, 2008; Armbruster *et al.*, 2009; Freeman *et al.*, 2014; Akiha *et al.*, 2018; Deslauriers *et al.*, 2019; Theobald *et al.*, 2020). Coupled with expanding interest in the field of biology education research (BER), the last decade has seen an increase in publications about biology undergraduate–specific pedagogy and teaching practices (NRC, 2012). However, a majority of the publications regarding BER are focused on experiences at 4-year universities (Schinske *et al.*, 2017; Thompson *et al.*, 2020). The disproportionate representation of 4-year universities means that the student populations of community colleges (including 2-year public colleges and technical colleges) are underutilized and underrepresented. Therefore, the inclusion of community college biology education research (CC BER) in the national conversation has the potential to positively impact a large proportion of students who have been traditionally underrepresented, in turn shedding light on important issues of inclusion in science, technology, engineering, and math (STEM) education (Thompson *et al.*, 2020).

Recent studies have highlighted the lack of community college involvement in published BER works. For example, between 2002 and 2015, only 1–3% of publications in BER journals represented studies with a community college focus or representation (Schinske *et al.*, 2017). In this context "representation" means having an author from a community college, research conducted at least partially in a community college context, or both. When *Cell Biology Education—Life Sciences Education* (*CBE-LSE*) articles from 2002 to 2015 and Society for the Advancement of Biology Education Research (SABER) abstracts selected for presentation at the SABER annual meeting from 2011 to 2015 were combined, CC BER representation rose to 7% (Lo *et al.*, 2019; Hsu *et al.*, 2021).

Five years have passed since Schinske *et al.*'s (2017) call to action—likely sufficient time to detect changes in the representation of CC BER in the literature and capture potential trends. In the work described herein, we sought to answer the following research question: How has CC BER progressed since the previous call for broadening participation?

METHODS

To evaluate how much CC BER is represented in publications, Schinske *et al.* (2017) conducted a literature review of seven journals that publish BER on a regular basis. The seven journals surveyed were *Anatomical Sciences Education*, *Advances in Physiology Education*, *BioScience*, *Journal of Microbiology and Biology Education*, *Journal of College Science Teaching*, *CBE-LSE,* and the *American Biology Teacher*. Schinske *et al.* (2017) examined data from these seven journals from January 2012 to September 2015. Because this paper is a follow-up to that work, we probed the same journals from January 2016 to December 2020.

Each of the seven journal archives was accessed online to record 1) the total number of publications per year, 2) the total number of CC BER publications, and 3) the topic of each CC BER publication. The topic for each CC BER publication was described by Schinske *et al.* (2017) as curricula and pedagogical methods, equity and diversity, degrees and transfer, or others. These categories are based on the research needs identified in a National Academies report (Olson and Labov, 2012). The total number of publications per year was determined by reviewing the table of contents for each issue within the allotted time frame and counting the publications that fit into the categories of research articles, teaching tips, essays, case studies, review articles, letters to the editor, or editorials. Article type categories are defined in Supplemental Table 1. Book reviews and calls for papers were excluded.

The total number of CC BER publications was determined by counting the number of BER publications with a community college study context and those with a community college–affiliated author. We defined a community college study context as publications by any authors that focused on community college biology teaching and learning or used community college students as a source of data. Authors were determined to have a community college affiliation if the college listed was a 2-year, associate degree–granting institution as defined by the American Association of Community Colleges (AACC, 2021).

Four researchers (A.O., N.C., K.M., C.A.) independently reviewed the publications in the seven journals between 2016 to 2020. Different combinations of two researchers reviewed each journal for evidence of community college–specific context, use of community college data, or presence of a community college faculty member as an author and categorized each publication into one topic type. Publications that did not fit into one of the topic types or seemed to fit into more than one topic (e.g., a pedagogical technique used to address classroom equity) were discussed during consensus coding to determine which category was most appropriate. After coding independently, researchers discussed conflicting codes and arrived at finalized codes via group consensus (Eby *et al.*, 2009). The consensus coded results were compared with the Schinske *et al.* (2017) findings to determine how CC BER publication rates changed during the allotted time period. The lead authors met with J. Schinske and L. Corwin to ensure the analysis mirrored that of the 2017 article, and J.H. was involved in both the 2017 work and this work to ensure consistency in the literature review and analysis.

RESULTS

From 2016 to 2020, the journals *Anatomical Sciences Education*, *Advances in Physiology Education*, *BioScience*, *Journal of Microbiology and Biology Education*, *Journal of College Science Teaching*, *CBE-LSE*, and the *American Biology Teacher* published 2503 papers that fit into the categories of research articles, teaching tips, essays, case studies, review articles, letters to the editor, or editorials. Of the 2503 papers, 5.9% (147 papers) were classified as CC BER because they included one or more community college faculty authors, a community college biology teaching and learning context, and/or community college students as a source of data (Table 1 and Figure 1). A full list of the 147 CC BER papers is provided in Supplemental Table 2. Schinske *et al.* (2017) reported 1741 total papers from the same seven journals from January 2012 to September 2015, of which 3.2% were CC BER. A chi-square test of independence was performed, and the relation between these variables were significant, $\chi^2(1, N = 4484) = 14.9$, $p = 0.0001$. The overall rate of CC BER publication increased from 15.2 papers/year (Schinske *et al.* 2017) to 29.4 papers/year in 2016–2020.

TABLE 1. Total papers surveyed, total BER papers that were community college–related (CC BER), and percentage CC BER in the seven journals listed between 2012 and September 2015 (data from Schinske *et al.*, 2017) and 2016–2020 (this analysis)

Journal	Total papers 2012–September 2015	CC BER papers 2012–September 2015	% CC BER papers 2012–September 2015	Total papers 2016–2020	CC BER papers 2016–2020	% CC BER papers 2016–2020
Advances in Physiology Education	243	1	0.41	505	10	1.98
American Biology Teacher	557	14	2.51	492	33	6.71
Anatomical Sciences Education	239	1	0.42	324	1	0.31
BioScience[a]	36	1	2.78	30	1	3.33
CBE—Life Sciences Education	249	7	2.81	452	48	10.62
Journal of College Science Teaching	257	17	6.61	310	25	8.06
Journal of Microbiology and Biology Education	196	16	8.16	390	29	7.44
Total	1777	57	3.2%	2503	147	5.9%

[a]For *BioScience*, only education-related publications were included.

The majority of the CC BER publications included a community college author (78.9%), with the remaining publications qualifying as CC BER by having a community college context or using data collected from community college students (Table 2). Of the 147 CC BER papers surveyed, 40.8% had a community college–affiliated author listed but did not have a community college context, 38.1% had both a community college–affiliated author listed and a community college context, and 21.1% lacked a community college–affiliated author but had a community college context.

Of the CC BER articles, the most common article type was research articles, accounting for 63.3% of publications (Supplemental Table 3). Essays accounted for 17.7%, teaching tips for 13.6%, case studies and editorials accounted for 2% each, and review articles and letters to the editor accounted for 0.7% each. The most common topic of the papers surveyed was curricula and teaching, accounting for 73.5% of publications, followed by equity and diversity (15%), degrees and transfers (6.8%), and others (4.8%; Supplemental Table 4).

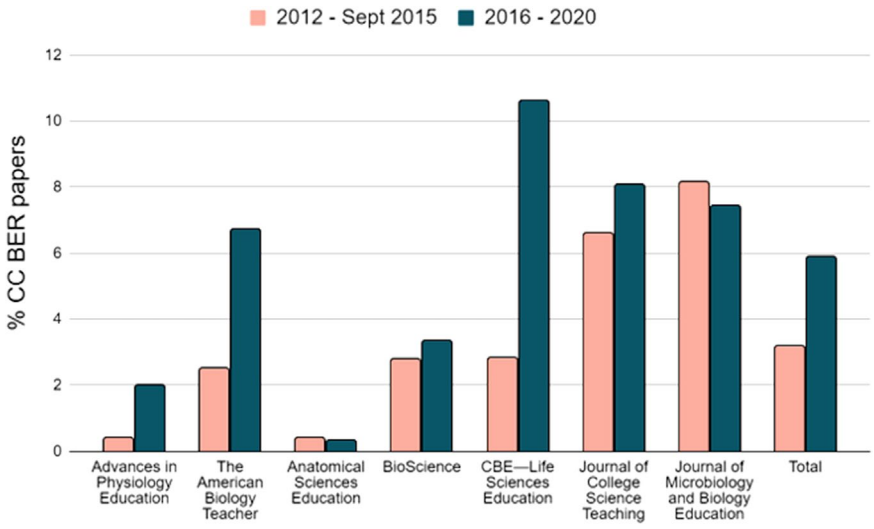

FIGURE 1. A comparison of the percent of BER papers that were community college related (no. of CC BER papers/total papers) in the seven journals listed between 2012 and September 2015 (data from Schinske *et al.*, 2017) and 2016–2020 (this analysis).

In total, 161 individuals affiliated with community colleges published CC BER papers in these journals between 2016 and 2020. When comparing the authors of the CC BER articles found in the Schinske *et al.* (2017) analysis to the articles in this study, we observed that 12 authors appeared on both lists, indicating that 149 community college–affiliated authors were newly involved in publishing (or had previously published, but not between the years 2012 to 2015) in 2016–2020 (Figure 2).

DISCUSSION

We document a significant increase in CC BER publications from 3.2% of publications, a rate of 15.2 papers per year, to 5.9% of publications, a rate of 29.4 papers per year (Schinske *et al.* 2017). In the years since the call to action, the rate of CC BER publication per journal has fluctuated, but overall is increasing. Assigning cause to this increase is beyond the scope of this work; however, possible mechanisms include the actions of networks specifically focused on increasing CC BER (e.g., Community College Biology Instructor Network to Support Inquiry Into Teaching and Education Scholarship [CC BIO INSITES]; Chen Musgrove *et al.*, 2022; and Equity and Diversity in Undergraduate STEM (EDU-STEM); Thompson *et al.*, 2020). In addition, as BER becomes increasingly visible (Lo *et al.*, 2019), more community college faculty may see themselves as contributing to BER as a form of scholarship that does not distract too much from their regular teaching commitments. However, the increased prevalence of CC BER publications still does not reflect the number of students who attend community colleges. Therefore, it is worthwhile to consider how best to remove barriers and leverage existing opportunities to further advance CC BER (Brownell and Tanner, 2012; Schinske *et al.*, 2017; Thompson *et al.*, 2020). The lack of the necessary research infrastructure (e.g., institutional review board offices and funding opportunities) has previously been identified as a barrier to faculty participation in BER (Schinske *et al.*, 2017;

TABLE 2. Total BER papers that were community college related (CC BER), number of papers that had a community college author without a community college study context, number of papers without a community college author with a community college context, and number of papers with both a community college author and a community college context between 2016 and 2020

Journal	Total CC BER papers	CC BER papers without a CC study context but with 1+ CC authors	CC BER papers with a CC study context but without a CC author	CC BER papers with both a CC study context and 1+ CC authors
Advances in Physiology Education	10	7	0	3
American Biology Teacher	33	30	0	3
Anatomical Sciences Education	1	1	0	0
BioScience	1	1	0	0
CBE—Life Sciences Education	48	8	21	19
Journal of College Science Teaching	25	3	3	19
Journal of Microbiology and Biology Education	29	10	7	12
Total (%)	147	60 (40.8%)	31 (21.1%)	56 (38.1%)

National Science Foundation [NSF], 2019). Scarcity of time and large teaching loads can overwhelm community college faculty to the exclusion of other activities (Sperling, 2003; Murray, 2004), and faculty motivation in a community college context is largely understudied (Hardré, 2012).

One way to increase community college faculty participation in BER may be for researchers from research-intensive institutions to invite community college faculty to participate in question formation, data collection, and writing of the publications (Thompson *et al.*, 2020). Inviting, and subsequently supporting, community college faculty to attend and present at BER-focused meetings such as the annual SABER, National Association of Biology Teachers, or National Association for Research in Science Teaching conferences could increase participation, disseminate information regarding funding, and highlight opportunities to network. Presentations by community college faculty represented 1% of presentations between 2011 and 2015 (Lo *et al.*, 2019) and increased to 4.8% in 2021 (SABER, 2021). One possible explanation for the increased community college faculty participation in 2021 is that the SABER conference was free and virtual. Virtual (or hybrid) meetings provide opportunities for greater inclusion overall (Sarabipour, 2020), and

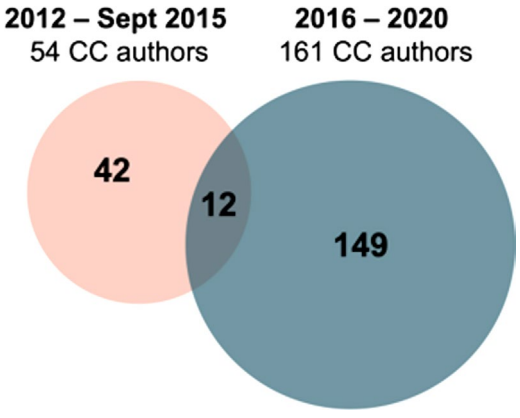

FIGURE 2. Venn diagram highlighting the 12-author overlap of the 54 individual community college–affiliated authors listed between 2012 and September 2015 (data from Schinske *et al.*, 2017) and the 161 individual community college–affiliated authors listed in 2016–2020 (this analysis).

community college faculty may benefit from virtual attendance as a continued option at a variety of national conferences.

Inter- and intra-institutional collaborative research is especially beneficial for faculty at non–research intensive institutions who have little time and resources to devote to research programs (Simmons *et al.*, 2016; Thompson *et al.*, 2020). Collaborative efforts provide opportunities for peer mentoring, networking, and pedagogical benefits that can motivate instructional innovation (Grunwald and Peterson, 2003; Simmons *et al.*, 2016). In line with the importance of these networks, the NSF has funded Research Coordination Networks (RCN) that focus on facilitating communication and coordination between scientists and educators who share the common goal of improving undergraduate biology education (via the RCN-UBE program; Pelaez *et al.*, 2018). These networks offer access, via financial and collegial support, to educational resources and meetings (e.g., Howard Hughes Medical Institute, *CourseSource*, Open Educational Resources Commons [OER Commons]), collaboration with members to develop resources and find pedagogical support for *Vision and Change* (e.g., Partnership for Undergraduate Life Sciences Education, National Institute on Scientific Teaching, Inclusive Environments and Metrics in Biology Education and Research [iEMBER]), networks that focus on undergraduate research opportunities (e.g., Community College Undergraduate Research Initiative [CCURI]), and networks that focus on collaborative BER (e.g., EDU-STEM, CC Bio INSITES). For contact information for the STEM education research networks mentioned, see the Supplemental Material.

Ultimately, faculty and researchers are motivated by a combination of internal and external factors. While many community college faculty members may see CC BER as important and satisfying, this type of professional activity may be difficult to maintain without external incentives. Thus, having an institutional culture that values CC BER and realizes its benefits locally is probably key to increased CC BER (Harrington *et al.*, 2021). Determining how best to communicate these benefits is beyond the scope of this contribution but is worthy of further investigation.

LIMITATIONS AND FUTURE DIRECTIONS

The authors acknowledge that part of the time period in which data were collected for this article coincided with the COVID-19

pandemic, which may have affected the results. The novel coronavirus outbreak was declared a global health emergency on January 30, 2020 (World Health Organization, 2021), meaning just under one-fifth of the papers examined in this literature review were published during a global crisis. Given the lengthy progression from data collection, through submission, review, and revision, we think the pandemic is unlikely to have notably affected our findings, and we did not observe fewer CC BER papers published in 2020 compared with other years (Woolston, 2015; Powell 2016; Supplemental Table 1). However, because the pandemic necessitated increased teaching workloads, COVID-19 may have influenced the types of articles or main topics published. Once the COVID-19 pandemic is fully contained, a follow-up literature review to compare publication topics and rates pre-, mid-, and postpandemic would determine whether there was a significant impact on BER literature and community college representation during and beyond 2020.

The recent trend in removing the word "community" from the name of community colleges necessitated that each institution was researched to determine eligibility, thus ensuring that no community colleges were missed in our survey of author affiliations (Muhlstein, 2014; Weissman, 2022). As the prior work may not have needed to employ similar research into college eligibility based on name, our estimates of an increase in CC BER publications may seem erroneously generous if some community colleges were previously excluded for lacking the word "community."

While some community college faculty currently participate in CC BER and RCNs, there is room for more community college inclusion. Continued monitoring of community college participation in BER is needed to characterize the trajectory and strength of increasing CC BER publication rates. In particular, future research into how often CC BER work is submitted for publication versus distributed locally is warranted. It would be useful to know how often community college faculty are invited to participate in the planning and design stages of research and what the barriers to inclusion may be and to track future author participation to determine how many new author names are included each year. An analysis of the effect of journal editors and the rate of manuscript acceptance or rejection of CC BER would be beneficial, as would consensus about how to specifically measure the success of CC BER representation. Further research on how the needs of community college undergraduate biology students are different and similar to those at other institutions would help solidify the importance of including community college perspectives in the larger BER conversation. We encourage our community college faculty colleagues to consider joining one or more of the networks mentioned earlier and to share research findings resulting from work with their peers and students. Finally, it is our hope that this work acts as a call to action for similar BER representation studies focusing on other higher education institutions such as historically black colleges and universities, minority-serving institutions, tribal colleges and universities, Hispanic-serving institutions, primarily undergraduate institutions, liberal arts colleges, comprehensive universities, and others.

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