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Campuses as living labs for sustainability problem-solving: trends, triumphs, and traps

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Abstract

Colleges and universities around the world are increasingly using their campuses as living laboratories for sustainability problem-solving and engagement. "Campus-as-lab" (CAL) projects emphasize experiential learning and campus sustainability through the integration of research and campus operations. By engaging students in CAL work, campuses make themselves more sustainable while contributing to knowledge and research needed to make an impact beyond their borders. The Sustainability Tracking, Assessment, and Rating System (STARS) is an important tool to track work in this rapidly evolving CAL arena. Here, we use data from STARS 2.0 to assess the self-reporting and concentration of CAL efforts in 14 operational and administrative areas across institutions of higher education in North America. We analyzed self-reported STARS reports in 2016 and 2018 and found that there was a 203% increase in institutions self-reporting CAL efforts (2016: $n = 171$; 2018: $n = 347$). Most efforts tend to be concentrated in the operational categories linked to the built environment. Socially explicit categories such as Diversity and Affordability, however, show increases in self-reporting. We identify nascent CAL priority areas, including the arts and biodiversity and conservation, as well as significant mis- or over-reporting of CAL efforts. To optimize the utility of STARS as a metric for capturing sustainability problem-solving efforts through CAL activities, process revisions are needed to ensure that institutions of higher education are accurately interpreting and self-reporting CAL work and that the STARS tool adequately captures the changing role that sustainability plays on university campuses in North America and beyond.

Keywords AASHE · Campus-as-lab · Campus sustainability · Campus systems · STARS · Sustainable operations

Introduction

In the face of urgent global sustainability challenges, institutions of higher learning are uniquely positioned as generators of cutting-edge solutions. By leveraging their dual role as educators of future leaders and sites of innovation and experimentation, campuses have a responsibility to drive both cultural and scientific responses to the complex and interrelated sustainability challenges humanity faces today (AASHE 2017a). Various approaches to sustainability education have been proposed that aim to link academics and operations through collaborations between students, researchers, and stakeholders. The "whole-of-university" approach emphasizes using the campus as a living laboratory for problem-solving through hands-on projects that link curriculum, research, and sustainable campus operations (McMillin and Dyball 2009) and also includes community outreach and policy approaches focused on the utilization of campus facilities (Lidstone et al. 2015). Moreover, problem- and project-based learning (PPBL) also emphasizes collaborative learning and the involvement of stakeholders to tackle complex societal issues (Adomssent et al. 2007; Wiek et al. 2013).

Arguably, one of the most important outcomes of using the campus as a living laboratory for sustainability problem-solving is the connections that are made visible to students and the campus community between theory and practice, as well as between the university campus and the world (McMillin and Dyball 2009). Other

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outcomes that result from these styles of learning approaches include capacity and attitude development of members of the campus community (Wiek et al. 2013), operational and reputational benefits for the institution (McMillin and Dyball 2009), and policy-relevant reports and project results (Cörvers et al. 2016). Applied sustainability problem-solving, especially initiatives that involve comprehensive collaborations between students, faculty, and staff on university campuses (e.g., by using the campus as a living laboratory for collaborative problem-solving), is increasingly gaining attention throughout North American institutions of higher education (Bilodeau et al. 2014; Lindstrom and Middlecamp 2017; Zen 2017). The trends in the increase or decrease of these initiatives, however, remain unknown.

At the time of this writing, nearly 1000 institutions across North America and beyond were publicly sharing their sustainability performance data via the Association for the Advancement of Sustainability in Higher Education (AASHE)'s Sustainability Tracking, Assessment, and Rating System (STARS) tool (AASHE 2019). STARS serves as a "transparent, self-reporting framework for colleges and universities to measure their sustainability performance" (AASHE 2015). Institutions that choose to self-report under STARS are awarded credits in the broad categories of Academics, Engagement, Operations, Planning, and Administration, as well as Innovation and Leadership initiatives, with more specific performance indicators and criteria under each broad category. By publicly reporting sustainability data using the STARS framework, campuses become eligible to earn designations ranging from "STARS Bronze" to "STARS Platinum." In 2018, 63% of parents and teens responding to a Princeton Review "College Hopes and Worries" survey indicated that having information about a campus' commitment to sustainability would influence their decision to attend or apply to that school (Princeton Review 2018). As the STARS framework is so widely used, a high STARS score can have significant implications for an institution's reputation, enrollment, and even financial bottom line.

STARS was launched in 2008 as a pilot (version 0.4) and has iteratively made process improvements and launched new versions. STARS 2.0 was released in 2014 and for the first time included a "Campus as a Living Laboratory" (henceforth referred to as "campus-as-lab" or CAL) credit under the Academics category. To earn points under the CAL credit, institutions must

> …[U]tiliz[e campus] infrastructure and operations for multidisciplinary student learning and applied research that contributes to understanding campus sustainability challenges or advancing sustainability on campus…[t]his...includes substantive work by students and/or faculty (e.g., class projects, thesis projects, term papers, published papers) that involves active and experiential learning… (AASHE 2017b)

Campuses wishing to report under STARS are provided with the STARS Technical Manual (AASHE 2017b), an extensive guide to reporting standards with examples of acceptable reportable activities. Campuses can earn up to 4 points towards their STARS ratings by reporting CAL activity. According to the STARS Technical Manual (AASHE 2017b), an example of a CAL project in the area of dining services is "as a class project, students developed a business plan for a student-governed cooperative." A CAL project in the area of Public Engagement would be exemplified by "a qualitative survey of local community members affected by a proposed campus expansion," and the results would be presented to administrators. STARS 2.0 also recognizes CAL efforts for on-campus internships and non-credit work "as long as the work has a learning component," but does not recognize "immersive education programs, co-curricular activities, or community-based work" as CAL efforts because they are accredited under a different section (section *AC 5: Immersive Experience*) in the STARS self-reporting system (ASSHE 2017b).

In this study, we use STARS data to understand to what extent CAL efforts are concentrated in various administrative and operational areas across institutions of higher education in the USA and Canada. Through analyzing differences in the self-reported data for various CAL categories outlined by STARS for the years 2016 and 2018, we identify changes in CAL efforts across categories defined by STARS, changes in the number of institutions self-reporting CAL activities, nascent CAL priority areas, and opportunities for more efficient self-reporting by institutions of higher education in North America and beyond.

Methods

Using the STARS Data portal (https://stars.aashe.org accessed February 2016 and August 2018; Reports -> STARS Data), we downloaded spreadsheets of the STARS institutions that reported information under section *AC-8: Campus as a Living Laboratory* in February 2016 and August 2018. Under the tab "Score Display", we set the following criteria: Selected STARS Version: 2.0, Organization Type: All Institutions, and Column 1: Campus as a Living Laboratory. The spreadsheet was modified to create a database that included only institutions from the USA (2016: n = 152; 2018: n = 312) and Canada (2016: n = 19; 2018: n = 35). The downloaded spreadsheets were edited to omit any redundant mentions of institutions. The CAL credit in the STARS tool allows institutions to self-report CAL efforts under 14 categories, as well as an additional "Other" category. These categories were added to the spreadsheet to create the working database. For

the purpose of this study, the 14 categories were considered either "operational" or "administrative" (this dual categorization was decided by the authors and does not necessarily reflect the views of AASHE). Operational categories include Air and Climate, Buildings, Dining Services/Food, Energy, Grounds, Purchasing, Transportation, Waste, and Water, while administrative categories include the following: Coordination and Planning; Diversity and Affordability; Health, Wellbeing, and Work; Investment and Finance; and Public Engagement.

For the 2 years, we surveyed the CAL page for each institution and scored each category that contained any self-reported CAL work. All data reported under this category in STARS 2.0 includes projects and work conducted within a three-year timeframe. Moreover, scoring a category is only an indicator that CAL work was conducted in that area and does not measure the extent of the work performed (i.e., whether more than one project was conducted in any given area).

Furthermore, we surveyed the "Other" category for each institution and further subdivided this category in order to better understand the self-reporting tool and CAL efforts not covered in the 14 categories set by STARS. Identification of the subcategories was conducted through iterative exploration of emerging themes for the 2016 dataset. Any CAL efforts reported in this category that could have been reported under any of the original 14 categories based on the criteria defined by STARS was scored under an "over-reporting" sub-category.

Results

CAL efforts across administrative and operational categories

As of February 2016, 171 institutions in the USA and Canada reported data under the "Campus as a Laboratory" credit of the STARS 2.0 system, while 347 institutions reported CAL activities as of August 2018, representing a ~ 203% increase. Figure 1 shows the proportions of the reporting institutions conducting CAL work in each category across the 2 years. In addition, across all institutions, the average number of CAL categories covered per institution is 10 categories for both 2016 and 2018.

Most institutions appear to focus their CAL efforts in the operational categories (e.g., Air and Climate, Buildings, Energy, Grounds, Waste). Across both years, six of the nine operational categories contain reports from more than 80% of the institutions reporting CAL activities, and eight of the nine operational categories contain reports from more than 65% of institutions reporting CAL activities. The exception is the Purchasing category, in which 40% of institutions reported CAL activities in 2016 and 47% in 2018. Examples of reported activities in Purchasing include students jointly working with staff in Purchasing departments to develop sustainability plans and the establishment of

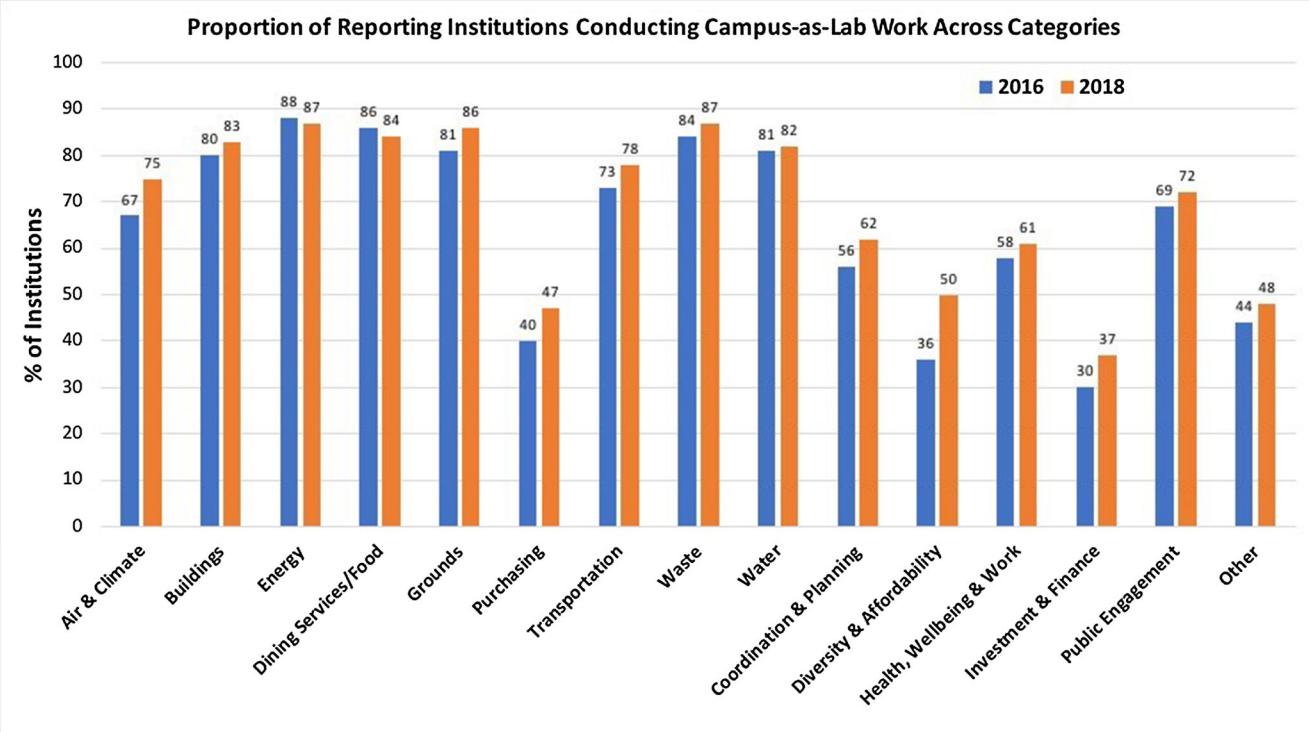

Fig. 1 Proportions of institutions reporting campus-as-lab work across 15 categories defined by STARS. As of February 2016, $n = 171$, and as of August 2018, $n = 347$. The categories are non-exclusive and thus do not add to 100. The figure was created using Microsoft Excel

donation and exchange programs aimed at sustainable trade of purchased items that can be recycled by the campus community.

Fewer institutions report CAL activities in the administrative categories (e.g., Coordination and Planning, Diversity and Affordability, Public Engagement). Within the administrative categories, most CAL efforts across reporting institutions have been conducted in the area of Public Engagement (69% of institutions in 2016; 72% of institutions in 2018), and the least amount of CAL efforts are reported under the Investment and Finance Category (30% of institutions in 2016; 37% of institutions on 2018). Examples of CAL activities under the Investment and Finance category include developing plans to better allocate student fees towards sustainable purchases and investments in more efficient campus utilities. The largest increase in CAL activities is seen in the Diversity and Affordability category (14% increase between 2016 and 2018). A key example within this category includes the development of a report that assesses the impacts of increasing awareness of Equity, Diversity, and Inclusion issues through the efforts of the Student Government and university staff and academics.

"Other" category

Forty-four percent of the institutions reported CAL work in the "Other" category in 2016 (n = 76) and 48% (n = 166) in 2018. Table 1 shows the various topic areas identified in the Other category and the number and proportion of institutions that reported CAL activities under each of these sub-categories. A significant amount of the reported information in this category was categorized as over-reported information (30% in 2016; 46% in 2018) that could have been reported under the other 14 categories using the criteria set by STARS. For the year 2016, most efforts that were not categorized as explicitly over-reported were in the areas of biodiversity/conservation/ecology (24%), culture/behavior change (14%), and visual and performing arts (11%). For the year 2018, there is a shift in the rankings, with most efforts concentrated in the categories of visual and performing arts (31%), curriculum development (27%), and biodiversity/conservation/ecology (13%).

Discussion

The significant increase in the number of institutions claiming campus-as-lab credit (~ 203% increase from 2016 to 2018) suggests that general concept of the campus as a living laboratory is emerging and growing as priority sustainability focus area across institutions of higher learning in North America. This is corroborated by cross-institutional efforts such as the Campus as Lab Community of Practice (Haddock and Savage 2020), where membership has grown from 60 CAL practitioners in 2016 to 156 as of early 2019. Despite this growing trend in general CAL reporting, our results reveal that the STARS 2.0 tool may not properly incentivize reporting on the full extent of CAL activities conducted at institutions, potentially resulting in significant over- or under-reporting of CAL efforts. When institutions self-report CAL engagement under each of the given categories, there is no metric that measures the extent to which CAL efforts are concentrated in each category at an individual institutional level; scoring a category is only an indicator that CAL work was conducted in that area and does not measure the extent of the work performed (i.e., whether more than one project was conducted in any given area). For example, one may report that one CAL project was conducted in the area of Buildings and eight were conducted in the area of Investment, but equal weight is given to each category in STARS when awarding credit simply because there has been *some* work reported under each category.

In addition, institutions must self-report activity in 10 of the 15 categories defined by STARS (including the "Other" category) to receive full points under the section *AC-8: Campus as a Living Laboratory*. Our results show that the average number of categories per institution for which CAL data were reported is 10 for both 2016 and 2018; this potentially reflects an incentive to self-report CAL activities in only up to 10 categories and also relying on the "Other" category for maximum scoring, as partial credit is given per category for work reported up to 9 categories and maximum credit is given for work reported in 10–15 categories. In 2016, 15 of the 35 institutions (43%) who only reported activities in 10 categories also reported information in the "Other" category, while 24 of the 59 institutions (41%) did so in 2018, thus our claim is

Table 1 Counts and proportions (in parentheses) of institutions reporting campus-as-lab activities in sub-categories within the "Other" category of STARS. Institutions reporting under "Other": 2016: n = 76; 2018: n = 166. The "Over-reporting" category is defined as campus-as-lab activities that meet the criteria for categorizing under the original 14 categories defined by STARS

Year	Art (visual/performing)	Biodiversity/conservation/ecology	CAL program development and implementation	Communications	Curriculum	Culture/behavior change	Garden/farm	Geography	Technology	Tours	Over-reporting
2016	8 (11)	18 (24)	4 (5)	7 (9)	6 (8)	11 (14)	6 (8)	2 (3)	3 (4)	2 (3)	23 (30)
2018	51 (31)	21 (13)	9 (5)	12 (7)	45 (27)	8 (9)	9 (5)	2 (1)	15 (9)	2 (1)	76 (46)

speculative, and can be corroborated with further studies and analyses that seek to understand administrators' individual reporting processes and justifications.

From a more optimistic perspective, the aforementioned trends in reporting may also be a more explicit indicator of the expanding work in the social dimensions of sustainability, which have not always been efficiently implemented (Murphy 2012). A metric that gives a weight to each category according to the number of projects reported would prove valuable in assessing CAL efforts across different areas. A weight for each category, coupled with data on key variables such as student population size and institution endowment size, would provide more robust data sets for critical analyses. In addition, partial scoring for all 15 categories, coupled with a weighted score per project reported, may more accurately reflect relative CAL efforts and changes over time across institutions.

The contemporary "green the campus" movement has historically placed little emphasis on issues such as social justice, workers' rights, gender studies, ethics, and many other topic areas within the spectrum of what defines campus and environmental sustainability (Breen 2010). Not surprisingly, the results of this study show that general CAL efforts are focused on the operational areas that are more intuitively associated with campus sustainability (e.g., dining, energy, waste, grounds, water, buildings), and are less focused on engagement with the socially explicit dimensions of sustainability (e.g., service, behavior, diversity and inclusion, governance, civic engagement). The CAL categories predetermined by STARS provide a snapshot of how institutions of higher education and environmental administrators define and interpret both "sustainability" and the concept of using the campus as a laboratory. Despite the differences in reporting, it is noteworthy that STARS also focuses on the more socially explicit categories of Coordination, Planning, and Governance; Diversity and Affordability; Health, Wellbeing, and Work; Investment and Finance; and Public Engagement. The inclusion of these areas allows for sustainability administrators to not only record CAL work that would otherwise be overlooked in the categories focused on the built environment, but also provide the opportunity and incentive for administrators and students to explore new types of projects and gain a greater "Campus as a Living Laboratory" credit score under STARS.

In addition, it is notable that there has been a large increase in reporting under the Diversity and Affordability category between 2016 and 2018, represented by a 14% increase in reporting institutions (36% of institutions reporting in 2016; 50% in 2018). Despite this increase, the low reporting when compared to other categories may be indicative of sustainability practitioners' lack of deep understanding on how to use the campus as a lab for Diversity and Affordability, as they may face challenges in interpreting and assessing these types of activity and gathering associated data. For example, one institution reported under this category how the campus garden is used to increase awareness of horticulture and culturally important plants through an internship program but does not allude to the applied research component that may constitute this type of activity as CAL work.

According to the results, sustainable investment and finance is the area that has received the least amount of efforts across all institutions for both years, with only 30% reporting CAL work in this area in 2016 and 37% in 2018. Jansson and Biel (2011) found that socially responsible investment among institutional investors is "guided by self-transcendent (environmental and social) values," and the lack of CAL efforts in this category may be reflective of the minimal emphasis placed on social values in the sustainability arena at institutions of higher education when compared to values focused on the built environment (those most likely to guide work in the operational categories). Moreover, Velazquez et al. (2005) identified various factors that influence sustainability in higher education; among them are lack of funding, lack of access to data, lack of performance indicators, lack of interdisciplinary research, lack of policies to support sustainability on campus, and lack of support from university administrators. As mentioned above, STARS requires that any self-reported CAL activities contain a learning component and result in positive sustainability outcomes on campus. We note that the Investment and Finance category may be susceptible to misreporting or over-reporting under the aforementioned criteria, as exemplified by one activity reported where students engaged in a poverty simulation that inspired them to consider future community service activities, but that did not result in the reporting or specification of sustainability outcomes for the activity. This type of activity would best be suited for reporting under section *AC 5: Immersive Experience*, which includes community-based internships and "transformative experiences" that have a long-lasting personal impact (AASHE 2017b). The aforementioned example highlights many other such types of examples reported that do not explicitly meet the CAL criteria and that can be reported under a different section under the STARS 2.0 system.

Institutions of higher education can use the data found in this study for self-appraisal in order to analyze CAL efforts at the individual institutional level, compare institutional CAL efforts to trends at the national level, and review increasing trends in CAL efforts in areas defined by STARS and other nascent CAL priority areas. According to the results, the least amount of CAL work is reported in the areas of Purchasing, Diversity and Affordability, and Investment and Finance. Although it may be challenging to conduct or accurately report CAL in these areas (e.g., purchasing activities may be interpreted as either waste reduction or behavior change activities), this provides an incentive for individual institutions to assess opportunities for engagement in these areas and contribute to the sustainability field through projects that advance underrepresented categories in institutions of higher education.

"Other" category

For the institutions reporting CAL in the Other category in 2016, 30% reported work that could have been classified under the original 14 categories according to the criteria set by STARS, and 46% of institutions reported such work in 2018. Potential reasons for reporting CAL in the Other category may include uncertainties as to how to classify CAL activities according to original categories; the need to highlight specific activities, whether because of novelty or the cross-disciplinary nature of the work; and uncertainties as to whether the activities are warranted the title of CAL. Nevertheless, we reiterate that self-reporting in the Other category contributes to the CAL score awarded to the institution, and in the case where an institution has reported activity in nine categories, reporting data in the additional Other category would award the institution full credit for the *AC-8: Campus as a Living Laboratory* score and enhance the overall rating awarded by STARS.

Although the inclusion of the aforementioned, more socially explicit categories helps to further validate the broader definition of the term "sustainability" and takes a step towards breaking out of a "mold" that has a technical and operational focus (Breen 2010), there are additional critical areas identified within the Other category that may also warrant their own categories in STARS. Most of the CAL work self-reported in the Other category for 2016 (with the exception of the over-reporting sub-category) was in the area of biodiversity, conservation, and ecology (24%). According to the guidelines set forth by STARS, it may be more appropriate to report this type of work under the "Grounds" category (as is exemplified by the Grounds CAL example in the STARS 2.0 Manual, which includes a "year-long study to catalog insect species found on campus"). However, the notion that about a quarter of the CAL work reported as "Other" in 2016 involves biodiversity, conservation, and ecology work may indicate that reporters perceive this focus area as a separate category in itself. For 2018, this sub-category ranks as the third most predominant under "Other", further indicating the potential perception of biodiversity, conservation, and ecology CAL activities as separate from CAL work in the predetermined Grounds or other categories. This notion is further exemplified by a self-reported example of how a graduate-level course uses the campus as a living laboratory by assessing the health of wildlife on the campus through the use of camera traps and using the results to inform conservation initiatives.

Culture and behavior change ranks as the second most reported sub-category in 2016 (14% of institutions) and is reduced in relative reporting in 2018 (9% of institutions) for the institutions reporting in the Other category. The areas of culture and behavior change are often overlooked in the greater realm of environmental sustainability (Levy and Marans 2011), yet are as equally important and relevant as the natural sciences (Paehlke 2005). A CAL study used a "Drink Local Program" to understand how water bottle consumption behavior can be used to change norms and promote water conservation behavior (Santos and van der Linden 2016). Moreover, data from an energy conservation competition in 2014 was used to understand intrinsic motivation and the drivers of pro-environmental behavior (van der Linden 2015). These examples can be potentially categorized under the areas of Water and Energy in STARS 2.0; however, the theme of behavior change is interwoven in both examples. These aforementioned studies highlight the importance of promoting behavioral and psychological research, especially in the context of CAL, and also serve as indicators of the shifting understanding, interpretation, and implementation of contemporary sustainability science.

Furthermore, visual and performing arts, which comprise 11% of the work reported under the Other category in 2016 and is the most predominant sub-category in 2018 (31%), have emerged as essential science communication tools whose very critical roles in sustainability have often been overlooked (Curtis et al. 2012). The results of this study indicate that CAL efforts in the visual and performing arts may also be perceived as an important and emerging separate category from those defined by STARS. Yet a challenge may arise in determining whether visual and performing arts activities may be better categorized and reported under the original categories such as Public Engagement (with positive sustainability outcomes for the campus) or Waste (if material is recycled for art projects), or whether a new category is warranted. For example, one institution reported in 2018 under the Other category that window glass from renovated residential halls is used by the Art Department for art projects; this type of activity may be categorized either under the original categories of Waste or Public Engagement depending on the reporters' perception or inherent, multi-faceted nature of the activity. To overcome the challenge of further misreporting through the addition of visual and performing arts and other nascent priority areas identified in this analysis, any process revisions for future STARS reporting must dictate precise and explicit descriptions of each category to clearly guide reporters. STARS would benefit through allowing reporters to provide descriptions of their rationale for reporting different activities in each category, which would not only help elucidate the reporting process but also assess whether the criteria outlined in the STARS manual are effective and not misinterpreted.

Conclusion

AASHE, and by association STARS, has an institutionalized role as "the information center for all green campus actions, and the measurement of those actions and dissemination of those measurements perpetuate the further narrowing of the scope and methods of campus sustainability" (Breen 2010).

The STARS tool has proven effective in allowing institutions of higher education to self-report CAL activities and in shedding light on the critical role of campuses as living laboratories for advancing sustainability practice and research.

Our study highlights that there is an opportunity for AASHE and institutions of higher education in North America to reevaluate the lens that they use when interpreting the components of what constitutes "campus sustainability" and what explicitly constitutes a campus-as-lab activity. Various sub-categories identified in this study under AASHE's "Other" category (Art, Curriculum Development, Culture/Behavior Change) showcase self-reported data that explicitly highlights our expanding understanding of campus sustainability. At the same time, changes to the STARS tool will be successful in direct proportion to the honesty with which institutions approach reporting. Institutions reporting through STARS should be mindful not to allow pursuit of STARS points on behalf of their own organizations to eclipse the credibility of the broader movement to make higher education more sustainable. We emphasize that there is an opportunity to revisit and possibly modify the categories explicitly defined under the "Campus as a Living Laboratory" section of the powerful STARS tool to further reflect the changing role that sustainability plays on university campuses in North America and beyond.

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References

Adomssent M, Godemann J, Michelsen G (2007) Transferability of approaches to sustainable development at universities as a challenge. Int J Sustain Higher Ed 8:385–402

Association for the Advancement of Sustainability in Higher Education (AASHE) (2015) The Sustainability Tracking, Assessment & Rating System (STARS). https://stars.aashe.org/. Accessed Feb 2016

Association for the Advancement of Sustainability in Higher Education (AASHE) (2017a) Beyond the right thing to do: the value of sustainability in higher education. https://www.aashe.org/wpcontent/uploads/2017/10/AASHE_2017_BeyondRightThingToDo_Brochure.pdf. Accessed July 2019

Association for the Advancement of Sustainability in Higher Education (AASHE) (2017b) STARS® technical manual version 2.1. https://www.aashe.org/wp-content/uploads/2017/07/STARS-2.1-Technical-Manual-Administrative-Update-Three.pdf. Accessed Feb 2016

Association for the Advancement of Sustainability in Higher Education (AASHE) (2019) STARS participants and reports. https://reports.aashe.org/institutions/participants-and-reports/. Accessed June 2019

Bilodeau L, Podger J, Abd-El-Aziz A (2014) Advancing campus and community sustainability: strategic alliances in action. Int J Sustain Higher Ed 15:157–168. https://doi.org/10.1108/IJSHE-06-2012-0051

Breen SD (2010) The mixed political blessing of campus sustainability. Polit Sci Polit 43:685–690

Cörvers R, Wiek A, de Kraker J, Lang DJ, Martens P (2016) Problem-based and project-based learning for sustainable development. In: Heinrichs H, Martens P, Michelsen G, Wiek A (eds) Sustainability science. Springer, Dordrecht, pp 349–358

Curtis DJ, Reid N, Ballard G (2012) Communicating ecology through art: what scientists think. Ecol Soc 17:3. https://doi.org/10.5751/ES-04670-170203

Haddock R, Savage C (2020) University partnership for sustainable development: campus as lab: using post-secondary campuses as petri-dishes for advancing the Sustainable Development Goals. Emerald Publishing

Jansson M, Biel A (2011) Motives to engage in sustainable investment: a comparison between institutional and private investors. Sustain Dev 19:135–142. https://doi.org/10.1002/sd.512

Levy BLM, Marans RW (2011) Towards a campus culture of environmental sustainability. Int J Sustain Higher Ed 13:365–377

Lidstone L, Wright T, Sherren K (2015) An analysis of Canadian STARS-rated higher education sustainability policies. Environ Dev Sustain 17:259–278

Lindstrom T, Middlecamp C (2017) Campus as a living laboratory for sustainability: the chemistry connection. J Chem Educ 94:1036–1042. https://doi.org/10.1021/acs.jchemed.6b00624

McMillin J, Dyball R (2009) Developing a whole-of-university approach to educating for sustainability. J Educ Sustain Dev 3:55–64

Murphy K (2012) The social pillar of sustainable development: a literature review and framework for policy analysis. Sustainability 8:15–29

Paehlke R (2005) Sustainability as a bridging concept. Conserv Biol 19:36–38

Princeton Review (2018) The Princeton review releases its "Guide to 399 Green Colleges" For 2018. https://www.princetonreview.com/press/green-guide/press-release. Accessed 7 July 2019

Santos J, van der Linden S (2016) Changing norms by changing behavior: the Princeton drink local program. Environ Pract 18:1–7

van der Linden S (2015) Intrinsic motivation and pro-environmental behaviour. Nat Clim Chang 5:612–613

Velazquez L, Munguia N, Sanchez M (2005) Deterring sustainability in higher education institutions: an appraisal of the factors which influence sustainability in higher education institutions. Int J Sustain Higher Ed 6:383–391

Wiek A, Xiong A, Brundiers K, van der Leeuw S (2013) Integrating problem- and project-based learning into sustainability programs. Int J Sustain Higher Ed 14:431–449

Zen IS (2017) Exploring the living learning laboratory: an approach to strengthen campus sustainability initiatives by using sustainability science approach. Int J Sustain Higher Ed 18:939–955. https://doi.org/10.1108/IJSHE-09-2015-0154