Students' Perception of Campus Sustainability in a Brazilian University

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1 Introduction

The sustainability issues in HEIs have been attracting a progressively increasing level of consideration from managers and scholars. Hundreds of applicational case studies of sustainable practices in HEI and dozens of sustainable assessment tools (SATs) have been created since the emergence of the environmental crisis reported in Stockholm, 1972.

Until now, much relevant knowledge has been generated on the topic of the sustainable system and SATs for HEIs. However, HEI are complex institutions composed of several interdependent subsystems, therefore sustainable improvement requires a holistic and integrated system and assessment measures to ensure its compliance with the established goals (Leal Filho et al. 2019a; Tim and Jutidamrongphan 2018). Despite the vast literature produced concerning sustainability in higher education, the need for the development of integrated and holistic systems to manage HEIs'

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W. Leal Filho et al. (eds.), *Universities, Sustainability and Society: Supporting the Implementation of the Sustainable Development Goals*, World Sustainability Series,
https://doi.org/10.1007/978-3-030-63399-8_19

efforts in assuming their role in implementing sustainability is still acknowledged. This claim is directed both to HEIs' internal routines and, from a broader perspective, to a global movement towards a more sustainable society.

In the existing literature, more attention has been given to the development of objective assessment tools, rather than human-centred ones which allow the generation of knowledge about the perception of individuals that make up an HEI, such as students, teachers, or staff. To date, no stakeholder perception study on the sustainability of HEIs has been identified that would consider the possibility of integrating their assessment tools with the sustainability dimensions already consolidated in the literature.

In order for HEIs to successfully achieve the sustainability goals, the cooperation and participation from all stakeholders are critical, which includes staff, faculty, students, funding bodies, government, employers, suppliers and community (Green 2013; Leal Filho et al. 2019b; Sammalisto et al. 2015). Among all of them, students appear as one of the key stakeholders in universities, not only for their much bigger number and HEIs' main target mission but also since there is empirical evidence that they have shown willingness to support and participate in university sustainable practices (Emanuel and Adams 2011). Many authors note the importance of placing students engaged in the university's sustainable practices as active agents of change, although they also recognise that there is still a dearth of previous studies about students' perception of sustainability in HEIs (Blanco-Portela et al. 2018).

Nejati and Nejati (2013) support that understanding how students evaluate the sustainability practices implemented by HEIs is crucial as it allows the decision-maker to become aware of the HEI performance from the perspective of one of their major groups of stakeholders. For these authors, "the study of students' perceptions towards sustainability remains under-researched and needs to be further explored" (Nejati and Nejati 2013, p. 102).

Concerning the gaps previously discussed, related to the shortage of tools to assess HEI sustainability relying on stakeholders' perceptions, and the absence of assessment tools that support its integration with the quantitative indicators of HEIs' sustainability established in the literature, this study has two main goals. The first intends to contribute to the literature by designing a sustainability assessment tool to assess the students' perception of the campus's sustainability, based on a Brazilian HEI case study. The second aims to analyse the adherence of the designed tool to assessing the key dimensions of sustainability proposed in the literature.

2 HEIs' Sustainability

Since Stockholm, 1972, the higher education institutions (HEIs) have been adapting themselves to assume their social role in supporting societies in the promotion of sustainable lifestyles. From 2015, since the development of the new sustainable agenda, the Sustainable Development Goals (SDGs) have been established—an expansion of the eight Millennium Development Goals (MDGs), compounded by a set of actions grouped into 17 goals which aim to end poverty in all its forms by 2030 (Leal Filho et al. 2019b). This new agenda turns the role of HEIs into a more meaningful and convoluted challenger in terms of conceiving more sustainable societies.

Bizerril et al. (2018) recognise HEIs as a strategic agents in promoting sustainability. This perspective takes into account different aspects, such as the fact that they are institutions that promote innovation (Lozano 2006b); play a relevant role in the education of leaders, teachers and professionals from different areas of society (Cortese 2003); have been considered responsible for ensuring to ensure that the curriculum taught prepares individuals for sustainability challenges; take a leading role in promoting regional sustainable development (Karatzoglou 2013).

Hopefully, the students will become individuals prepared to understand the complexities of sustainability and to convert the knowledge acquired into systemic, anticipatory, critical thinking and actions to implement environmental management systems that support the social change to a more sustainable living standard (Brandli et al. 2011; Sammalisto et al. 2015). To overcome their challenges in the promotion of sustainability, HEIs should develop skills to reduce the environmental impact of their activities (Alshuwaikhat and Abubakar 2008; Findler et al. 2019). Thus, according to Ceulemans et al. (2015), university institutions, due to their specificities and importance, should be considered differently from other public or corporate institutions. To meet the expectations set out in the 2030 New Global Environmental Agenda, a lot of universities have taken on the challenge of incorporating sustainable development practices into their education, research, internal management, and community engagement processes. Higher education institutions taking action in this direction are being usually designated as sustainable HEIs.

Conceptualising the Sustainable University designation is not an easy task due to the variety and diversity of activities commonly undertaken in a university campus. Velazquez et al. (2006, p. 812) compiled empirical data from sustainable programmes and actions carried out by about 80 universities around the world and defined a sustainable campus as "a higher education institution, as a whole or as a part, that addresses, involves and promotes, on a regional or a global level, the minimization of negative environmental, economic, societal, and health effects generated in the use of their resources in order to fulfill its functions of teaching, research, outreach and partnership, and stewardship in ways to help society make the transition to sustainable lifestyles". This definition is mainly restricted to the minimisation of negative impacts already happening. As such, it tends to shorten HEI scope focusing on concrete and limited aspects, not addressing the proactivity in anticipating other effects and concerns related to the HEI complexity, the novelty of sustainability in this kind of institution and finally the new challenges related to sustainability issues that keep coming daily.

A definition that has been recurrently used, from Sterling et al. (2013, p. 23), states that a sustainable university is one that "through its guiding ethos, outlook and aspirations, governance, research, curriculum, community links, campus management, monitoring, and modus operandi seeks explicitly to explore, develop, contribute to, embody and manifest—critically and reflexively—the kinds of values, concepts, and ideas, challenges and approaches that are emerging from the growing global sustainability discourse". This last definition might be more appropriate since the authors perceive HEI from a much broader perspective. The HEIs' sustainability practices often extrapolate the boundaries of their geographical area, bringing benefits to their local, regional and sometimes national environment.

At the beginning of this century, the work of Cortese (2003) stated that the achievement of HEI sustainability is attained by considering the following four dimensions: education, research, campus operations and reporting. Later, Lozano (2006a) and Lozano et al. (2015) complemented the model including three more dimensions: institutional framework, on-campus experience and outreach and, finally, uniting the existing dimension reporting with the assessment practices. Table 1 details briefly each dimension of HEIs' sustainability proposed by Lozano et al. (2015).

Table 1 Dimensions of HEIs' sustainability

Dimension	Description
Education	It includes proposals related to the presence of sustainability themes in the course curriculum, the development of skills and teacher training programmes. This dimension relates not only to the theme of sustainable HEIs but also to a much broader scope of knowledge which includes the central role that education plays in the science of sustainability and the promotion of SD
Research	It is related to the existence of structures and financial support for the production of knowledge, technology and innovations in sustainability
Campus operations	It addresses the presence of sustainability practices in the day-to-day management of HEIs, including resource efficiency and management of water, energy, waste and greenhouse gases, transport and accessibility, as well as access to good quality food
Institutional framework	It deals with the commitment of the higher management and the councils of the institution to sustainable development. It considers the presence of DS in policies, missions and other official institutional documents
On-campus experience	It considers that working groups and other sustainable practices among students, teachers and staff are indicators of the daily presence of sustainability concerns in the academic community
Outreach	It refers to actions related to the integration of the university with society, which includes other universities, governments, companies, schools, civil society organisations and the local community
Assessment and reporting	It involves the implementation of an integrated environmental management system to monitor and control the environmental impacts of campus operations, processes and routines, as well as the internal and external dissemination of the results of this monitoring and the adoption of continuous improvement principles

Adapted from Lozano et al. (2015)

The model of Lozano et al. (2015), presented in Table 1, has been broadly cited by many authors because it captures the core facets of HEI sustainability and, as shown later, its adherence to SATs was empirically tested.

3 Sustainability Assessment Tools in HEIs

To endorse the effectiveness of HEIs' sustainability practices, various Sustainability Assessment Tools (SATs) were created and are considered a crucial element to enable the path towards sustainability. They support the HEIs' decision-makers on the improvement of their plans and policies towards a sustainable higher education institution and make it possible to publish the sustainability reporting of HEIs (Berzosa et al. 2017).

The work of Lambrechts (2015), which provides an overview of existing sustainability assessment tools, identifies the SAT contribution to the HEIs' sustainability process as threefold. According to this work, SATs usually contribute to (1) policy development; (2) mainstreaming sustainable development in higher education, and finally, (3) improving transparency and communication.

Fischer et al. (2015) studied 12 sustainability assessment tools in HEIs to analyse the understandings of a sustainable university that are underpinning contemporary sustainability assessment tools. Their research findings showed that these SATs comprised at least three different monitoring purposes, from affording compliance to predetermined standards, to determine the state of internal processes, and to provide data for competitive performance comparisons. Several other authors carried out similar comparative SATs analysis.

Yarime and Tanaka (2012) used a mixed-method approach and analysed 12 SATs, and the results showed that most tools indicators were focused on operations (44%), governance (39%) and education (8%). Berzosa et al. (2017) simultaneously applied three SATs to compare on a real case study, namely to assess the sustainability of the Universidad Europea de Madrid (UEM) in Spain. The authors analysed advantages and differences between tools and concluded that it may be feasible to use more than one tool for diagnosis and planning. In another study by Asmuss and Kamal (2013) four tools were reviewed to select the best benchmarking tool for the purposes of the University of Saskatchewan (UofS) in Canada. This work considered the following five areas of campus life: education, operation, governance, research and community engagement. After analysing the strengths and weaknesses of each of the following tools: Sustainability Assessment Questionnaire (SAQ), the Campus Sustainability Assessment Framework (CSAF), the College of Sustainability Report Card (CSRC), and the Sustainability Tracking Assessment and Rating System (STARS), the last one was chosen. STARS was considered by the authors to be the best benchmarking tool to satisfy the UofS's needs for assessing sustainability in all designated areas of campus life—education, research, operations, governance and community engagement.

Finally, in the work carried out by Findler et al. (2018), the extent to which SATs are capable of measuring the impact that HEIs have on sustainable development was analysed. To achieve the purpose of their study, the authors performed the analysis of 19 SATs and 1134 indicators for sustainability assessment. According to the adopted methodology, each indicator was exclusively assigned to one of the Lozano et al. (2015) sustainable development dimensions. Those indicators related to administrative structure and broad-scale policies were assigned to the institutional framework, while indicators addressing assessment and reporting processes were categorised into the "Assessment and reporting" dimension. Further, indicators related to the HEIs on an institutional level were related to the new category "higher education institution (HEI)", such as demographic effects on the region through student in-migration. The column "not applicable (NA)" included those that did not fit in any of the other dimensions of the Lozano et al. (2015) model. Table 2 presents these SATs and their relation to the seven Lozano et al. (2015) sustainable development dimensions and, also the new categories, HEI and NA, as proposed by Findler et al. (2018).

According to Table 2, the dimension with the highest number of indicators is Campus operations, followed by Institutional framework (20.90%), Education (16.04%) and Research (7.85%). The results are in line with the works of Fischer et al. (2015). The study of Findler et al. (2018) is particularly relevant because it highlights the possibility of a relationship between the sustainability indicators of the 19 studied SATs with the key dimensions of the sustainability proposed in the Lozano et al. (2015) model (Table 1).

Much of the attention of sustainability research focusing on HEIs has been directed towards the dimensions of education and research. Moreover, considerable attention has been given to isolated aspects of the campus sustainability operations dimension, such as green building (Hopkins 2016), waste (Zen et al. 2016) and carbon emission (Altan 2010; Larsen et al. 2013; Ramos et al. 2015). Nejati and Nejati (2013, p. 102) assert that "sustainability practices within the academic setting need to be understood and practiced by all members of the organization at various levels. Only then can a collective force for achieving the sustainability mission be mobilized successfully".

While literature concerned with Sustainable Assessment Tools (SATs) in HEIs recognises that most of those are focused on inside impacts, authors like Findler et al. (2019) and Beynaghi et al. (2016) have noticed that HEI sustainable development efforts have an effect that reflects beyond its organisational boundaries. The HEI SD impacts might emerge from a variety of contrasting areas such as economy, societal challenges, natural environment, policy making, culture, and demographics (Findler et al. 2018).

4 Students' Perception of Sustainable HEIs

Although tools that use perception measurement to assess sustainability in HEIs differ from traditional ones, which often use objective measurement variables such as energy consumption in kWh, water consumption in m^3, and tons of selective waste collection, among others, they contribute to a better understanding of HEIs' sustainability. The SATs performed by the subjective approach of assessing service users'

Table 2 Adherence between Lozano et al. (2015) sustainability dimensions and SATs

Sustainability Assessment Tools (SATs)	Institutional framework	Education	Research	Outreach	Campus operations	Campus experiences	Assessment and reporting	HEI	NA
AISHE[a], AMAS[b], BSIS[c], CSA[d], CSAF[e], D-SiM[f], DUK[g], GASU[h], GMID[i], P&P[j], PENN[k], SAQ[l], SCE[m], SPT[n], STARS[o], STAUNCH®[p], TUR[q], UIGM[r], USAT[s]	20.9	16.04	7.85	5.20	34.48	2.56	2.91	5.03	5.03

Source Adapted from Findler et al. (2018)
[a]Auditing Instrument for Sustainability in Higher Education; [b]Adaptable Model for Assessing Sustainability in Higher Education; [c]Business School Impact System; [d]Campus Sustainability Assessment Review Project; [e]Campus Sustainability Assessment Framework; [f]Driving force-pressure-state-exposure-effect-action; [g]Deutsche UNESCO Kommission; [h]Graphical Assessment of Sustainability in Universities;[i]Graz Model of Integrative Development; [j]People and Planet's University League; [k]Penn State Indicators Report; [l]Sustainability Assessment Questionnaire; [m]State of the Campus Environment; [n]Sustainable Pathways Toolkit; [o]Sustainability Tracking, Assessment and Rating System; [p]Sustainability Tool for Auditing for University Curricula in Higher-Education; [q]Three-dimensional University Ranking; [r]UI GreenMetric World University Ranking; [s]Unit-based Sustainability Assessment Tool

perceptions of their sustainability effectiveness may complement a more holistic perspective, by bringing new insights to the assessment process. As a complementary approach, it would concur to a better understanding of HEIs' effort to become more sustainable.

The use of subjective tools to measure sustainability in HEIs may induce an improvement of social control in managing the HEIs' system, which is a gain in terms of governance, and, in addition, would improve the students' engagement, as key stakeholders, in achieving the institution's sustainability goals.

5 Description of the Study Areas and Methodology

5.1 Case Study

The Federal University of Paraíba is a national public university located in the north east of Brazil. It is the biggest of the Paraíba State. It has 127 undergraduate and 111 postgraduate courses that enrol 38,880 students. For this study, the sample was composed of students from two of the 16 HEI study centres, namely the Technology Centre and the Renewable Energy Centre. These two centres comprise most of the engineering courses offered by the HEI.

5.2 Research Methods—Scale Design

In line with Malhotra et al.'s (2018, p. 378) methodological proposal, a new multi-item quantitative tool was designed to measure students' perception of HEIs, following the steps shown in Fig. 1.

The first step encompassed an extensive literature review to identify the main dimensions of sustainability in higher education institutions. As presented in the

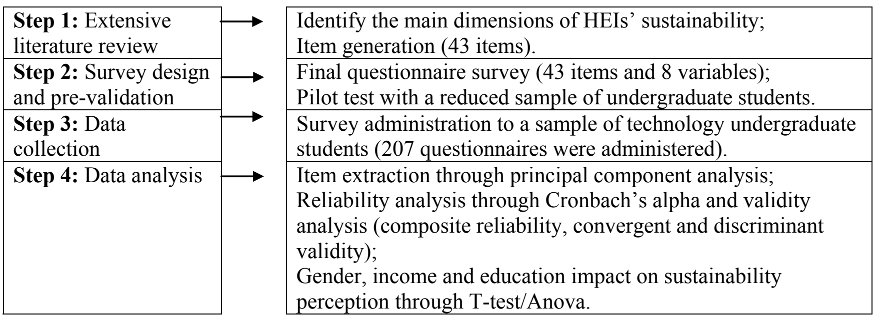

Fig. 1 Questionnaire development and validation process

introduction session, the sustainability of HEIs is composed of the seven following dimensions: (1) Education; (2) Research; (3) Campus operations; (4) Institutional framework; (5) On-campus experience; (6) Outreach; (7) Assessment and reporting. 43 items were generated through literature review, based on the works of Findler et al. (2019), Emanuel and Adams (2011), Lozano (2006a), Lozano and Young (2013), Nejati and Nejati (2013), Luiz et al. (2015), Savelyeva and Douglas (2017) and Thomashow (2014).

Once the set of items derived from the literature review was identified, the next step was the design of a final questionnaire comprising 51 items of which five were demographic (course, age, gender, income, education); three dichotomous questions to measure student connection with sustainability in the course; and the 43 items identified in Step 1. For the 43 multi-item scale, responses were provided using a five-point Likert-type scale from (1) strongly disagree to (5) strongly agree with a (3) neutral response option. Thus, the survey was refined through a pilot test, applying it to a reduced sample of 12 individuals to evaluate the following criteria: (a) assess respondent's reaction and understanding of the items and variables allocated on the questionnaire; (b) obtain feedback with regard to content, length, arrangement, wording accuracy and relevance. As a result of this phase, two items were rewritten to improve wording accuracy.

In Step 3, the final questionnaire was administered by a structured and assisted survey to a sample of 207 undergraduate students of 12 courses of engineering provided by the case study Brazilian university (Table 3).

After data collection, a statistical analysis of the results was conducted in Step 4. In this phase, as will be demonstrated in the results section, other items were discarded due to their lack of statistical adherence to the proposed tool. Finally, the methods adopted presented some limitations. For instance, the sample size and composition, although allowing the analyses performed, limited the possibility of generalising the results to other HEIs and to students other than engineering; the survey was designed to be comprehensive for the majority of respondents, however it may be challenging for some respondents to have enough knowledge about all topics addressed in the survey.

6 Results and Discussion

6.1 Principal Component Analysis

For grouping the items into their specific dimensions, the principal component analysis (PCA) was performed on the 43 items of the scale. To assess the factorability of the data and to ensure the adequacy of the sampling, Bartlett's Test of Sphericity and the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy were applied. The Bartlett's Test of Sphericity analyses whether the correlation matrix has significant correlations among at least some of the variables and it is significant ($p < 0.05$) for

Table 3 Demographic profile of respondents

Demographics	Frequency	Percentage (%)
Gender (valid N = 207)		
Male	138	66.70
Female	69	33.30
Age (N = 207)		
Below 20 years old	29	14.00
20–22 years old	77	37.20
23–25 years old	71	34.30
26–28 years old	18	8.70
Over 28 years old	12	5.80
Monthly familiar income (N = 184)		
Lowest thru 500€	90	43.50
500–999€	50	24.20
1000–1499€	30	14.50
1500–2000€	14	6.80
Over 2000€	23	11.10
Course (valid N = 202)		
Industrial Mechanical Engineering	27	13.40
Mechanical Engineering	30	14.90
Renewable Energy Engineering	35	17.30
Environmental Engineering	34	16.80
Civil Engineering	20	9.90
Industrial Engineering	19	9.40
Industrial Chemistry	5	2.50
Chemical Engineering	15	7.40
Electrical Engineering	14	6.90
Food Engineering	2	1.00
Materials Engineering	1	0.50

the PCA to be considered appropriate (Field 2009; Hair et al. 2014; Nejati and Nejati 2013). The KMO corresponds to a measure of sampling adequacy (MSA) that looks not only at the correlations but also at patterns between variables. It ranges from 0 to 1 and its accepted values are equal to or above 0.6 (Hair et al. 2014). Further, the component loadings were analysed. Based on sample size, a loading of 0.6 or greater on one component was considered significant (Hair et al. 2014). The values ranging from 0.609 to 0.850, as shown in the fourth column of Table 5, were considered as achieving the accepted threshold. To solve the cross-loading issues, the criteria adopted by Nejati and Nejati (2013) were used, whereby items having a loading

Table 4 Rotated component loading matrix (VARIMAX)

	C1	C2	C3	C4	C5	C6	C7	C8
Sum of squares (eigenvalues)	3.776	3.060	2.776	2.721	2.675	2.445	2.015	1.779
% of trace	12.149	9.871	8.954	8.777	8.628	7.887	6.500	5.738
Cumulative % of trace	12.149	22.020	30.973	39.751	48.379	56.266	62.766	68.504

difference across components less than 0.10 were suppressed. Applying the criteria described above, 11 items were removed from the model.

The final model was composed of 31 items, grouped into eight components with eigenvalues higher than 1, explaining 68.504% of the variance. The 31 items model obtained a significant Bartlett's Test of Sphericity ($p \approx 0.000$) and also collectively meets the necessary threshold of sampling adequacy, measured through KMO, with an MSA value of 0.860. The individual MSA of each item was also measured and these ranged from 0.709 to 0.933.

The items included in each component were considered, relating to the literature, and labelled as: 1—Waste (6 items), 2—Emissions/Procurement (3 items), 3—Energy (4 items), 4—Quality of Life in the Workplace (4 items), 5—Fauna and Flora (4 items), 6—Institutional framework (4 items), 7—Education/Research (3 items) and, 8—Water (2 items). The eigenvalue percentage of the trace of each component is presented in Table 4.

6.2 Reliability and Validity Analysis

To assess reliability, Cronbach's alpha was computed for each subscale. A commonly accepted rule of thumb for describing the internal consistency calculated by Cronbach's alpha is as follows: $\alpha \geq 0.9$: Excellent; $0.7 \leq \alpha < 0.9$: Good; $0.6 \leq \alpha < 0.7$: Acceptable; $0.5 \leq \alpha < 0.6$: Poor; $\alpha < 0.5$: Unacceptable (Hair et al. 2014; Jorge et al. 2015). As shown in the last column of Table 5, values of Cronbach's alpha (α) for each component range between acceptable and good.

Finally, to ensure the quality of measurement, the composite reliability, convergent validity and discriminant validity were also tested. Composite reliability (CR) is a robust measure of internal consistency in scale items (Byrne 2016). Fornell and Larcker (1981) found thresholds for composite reliability to be above 0.60. The values of CR, shown in Table 5, exceed the limits established in the literature. The average variance extracted (AVE) for each component surpasses the recommended level of 0.5 (Hair et al. 2014); thus, it is possible to conclude that convergent validity was achieved.

Table 6 summarises the measured coefficients for discriminant validity. The diagonal elements, in bold, are the square root of the average variance extracted (AVE).

Table 5 Descriptive statistics, loadings (VARIMAX), reliability and validity tests of constructs

Item	Mean	SD[a]	Load	Reliability validity
Component 1: waste	2.52	0.808		
The implemented composting system is efficient	2.77	0.942	0.769	CR[b] 0.85 AVE[c] 0.49 α[d] 0.871
UFPB encourages, through campaigns, the correct disposal of its waste	2.39	1.117	0.733	
UFPB has an efficient selective waste collection program	2.26	1.043	0.726	
UFPB performs proper disposal of its chemical waste	2.57	0.962	0.666	
UFPB promotes reverse logistics of cartridges and toners used by the Institution	2.70	0.928	0.662	
Recycling bins scattered around campus motivate students to discard waste properly	2.43	1.200	0.649	
Component 2: emissions/procurement	2.26	0.823		
UFPB prioritises the use of biofuels in its vehicle fleet	2.19	0.944	0.847	CR[b] 0.86 AVE[c] 0.61 α[d] 0.878
UFPB monitors greenhouse gas emissions from its fleet	2.03	0.975	0.820	
UFPB has procedures to optimise the use of its vehicle fleet	2.37	0.946	0.761	
UFPB cleaning, safety and telephone contracts take into account sustainability issues	2.43	0.895	0.683	
Component 3: energy	2.28	0.869		
UFPB invests in renewable energy generation strategies	2.25	1.059	0.753	CR[b] 0.83 AVE[c] 0.54 α[d] 0.834
UFPB embraces energy efficiency principles by replacing LED lighting	2.23	1.049	0.747	
UFPB adopts practices committed to reducing non-renewable energy use	2.27	1.002	0.731	
UFPB promotes campaigns to rationalise the use of electricity	2.37	1.137	0.719	
Component 4: quality of life in the workplace	2.86	0.894		
UFPB encourages respectful treatment among students	2.94	1.087	0.812	CR[b] 0.81 AVE[c] 0.52 α[d] 0.829
UFPB encourages respectful treatment between students and lecturers	2.96	1.112	0.809	
The UFPB workload required for course activities is adequate	2.67	1.128	0.623	
Student rights are respected	2.86	1.070	0.609	
Component 5: fauna and flora (ff)	3.03	0.817		

(continued)

Table 5 (continued)

Item	Mean	SD[a]	Load	Reliability validity
UFPB performs proper wildlife management on its campuses	3.14	1.143	0.799	CR[b] 0.80 AVE[c] 0.51 α[d] 0.757
UFPB takes care of its forest areas	3.44	1.073	0.729	
UFPB performs the correct management of domestic fauna on its campuses	2.43	1.205	0.681	
The institution complies with environmental legislation	3.12	0.842	0.627	
Component 6: institutional framework	2.82	0.767		
UFPB's portal and social media detail the institution's sustainability initiatives	2.77	0.983	0.755	CR[b] 0.78 AVE[c] 0.47 α[d] 0.778
UFPB has a specific sector to address the environmental issues of its campuses	3.21	1.067	0.739	
Overall, sustainability issues are adequately addressed at UFPB	2.65	0.948	0.636	
Important decisions related to campus sustainability are made in a participatory manner on university councils	2.65	0.958	0.613	
Component 7: education/research	3.30	0.855		
The course offers institutional research and extension programmes with themes related to sustainability	3.51	0.994	0.795	CR[b] 0.80 AVE[c] 0.57 α[d] 0.687
The institution's postgraduate programmes related to students' field of study offer sustainability-themed lines of research	3.19	1.107	0.780	
The course offers enough sustainability subjects for students' education	3.19	1.161	0.686	
Component 8: water	2.27	0.950		
The drinking water distributed by UFPB is of high quality	2.04	1.001	0.850	CR[b] 0.80 AVE[c] 0.68 α[d] 0.804
UFPB has a good drinking water supply	2.50	1.074	0.797	
Overall score for Student Perception of HEI's Sustainability (SPHEIS)[e]	2.67	0.560		

[a]SD: standard deviation
[b]CR: composite reliability
[c]AVE: average variance extracted
[d]α: Cronbach's alpha
[e]Average value obtained from scores of the items included in each category

Table 6 Discriminant validity coefficients

Component	C1	C2	C3	C4	C5	C6	C7	C8
C1—waste	**0.700**							
C2—emissions/procurement	0.325	**0.781**						
C3—energy	0.409	0.350	**0.735**					
C4—quality of life in the workplace	0.385	0.390	0.280	**0.721**				
C5—fauna and flora	0.358	0.233	0.383	0.367	**0.714**			
C6—institutional framework	0.375	0.329	0.379	0.463	0.345	**0.686**		
C7—education/research	0.163	0.226	0.075	0.272	0.156	0.302	**0.755**	.
C8—water	0.270	0.363	0.266	0.357	0.214	0.327	0.176	**0.825**

Off-diagonal elements are the correlation among components. To examine discriminant validity, diagonal elements should be larger than off-diagonal elements (Nejati and Nejati 2013).

6.3 Gender, Secondary Education and Income Analysis

Despite the gender difference between male (66.7%) and female (33.3%) in the number of students questioned, the t-test results show that there isn't statistical evidence to confirm gender influence on the perception of campus sustainability ($t(205) = 0.297$; $p = 0.767$), with male mean equal to 2.67 and female 2.65. This result is in line with the work carried out by Meek and Sullivan (2018) which developed a new measure of sustainability orientation among entrepreneurs. Further, the gender result is similar to the study carried out by Dagiliūtė et al. (2018) that compared students' attitudes towards sustainability in two Lithuanian universities. Although the study of Zhang et al. (2017) found that gender is influential on sustainability perception, using a sample of 509 undergraduate students from 10 university campuses in Beijing, China, we could not find evidence of gender differences on perception towards sustainability in the case of these Brazilian students.

Similarly to the gender result, no statistical evidence was found to assert that secondary education in public (mean 2.71) or private (mean 2.62) schools influences the perception of sustainability of the surveyed sample ($t(203) = -0.240$; $p = 0.216$). Lastly, there was also no statistically significant difference regarding income as a predictor of the perception of sustainability ($F(3;180) = -0.127$; $p = 0.944$). This result regarding income is congruent with the work of Bosona and Gebresenbet (2018).

6.4 Model Performance and Sustainability Perception for the Case Study

As a result of the principal component analysis, the 31 remaining items of the final model (Table 5) are related to five of the eight dimensions of the higher education sustainability model designed by Lozano et al. (2015), described in Table 1.

The components C1—Waste, C2—Emissions/Procurement, C3—Energy, C5—Fauna and Flora and C8—Water, are congruent with the dimension Campus operation. The component C4—Quality of Life in the Workplace has similarities with the dimension On-campus Experience; likewise the component C6—Institutional Framework is consistent with the analogous Lozano dimension. Component 7 (Education/Research) has items compatible with the dimensions Education and Research on Lozano's model. The items related to the dimensions Outreach and Assessment and report were removed in the refinement phase of principal component analysis. The adherence between the performance of the Student Perception of HEI's Sustainability (coined now as SPHEIS), which is the proposed model, and the one designed by Lozano et al. (2015) is illustrated in Fig. 2.

Results of the analysis indicate the following: firstly, five components obtained average scores above the midpoint of the scale (mean = 2.5). These are: C1 – Waste (mean = 2.52); C4—Quality of Life in the Workplace (QLW) (mean = 2.86); C5—Fauna and Flora (mean = 2.82); C6—Institutional Framework (mean = 2.82); and C7—Education/Research, which had the highest score, obtaining mean equal to 3.30. In contrast, the three following components achieved scores below the midpoint of the scale: C2—Emissions/Procurement, which obtained the lowest score, with mean equal to 2.26; C3—Energy (mean = 2.28); followed by C8—Water (mean =

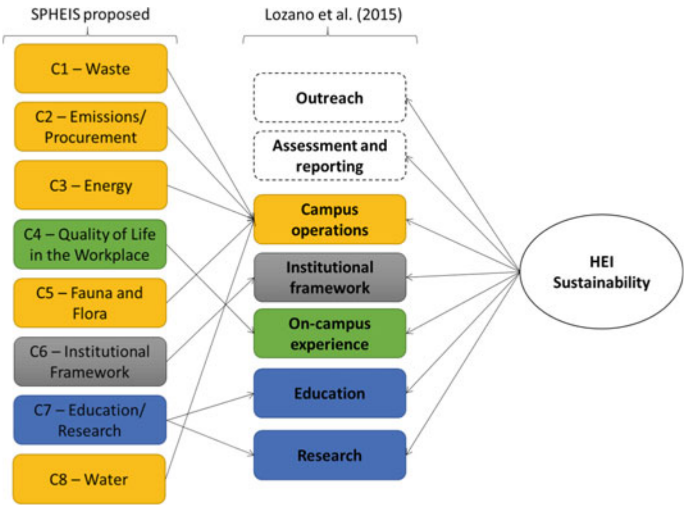

Fig. 2 Adherence between the proposed model SPHEIS and Lozano et al. (2015)'s model

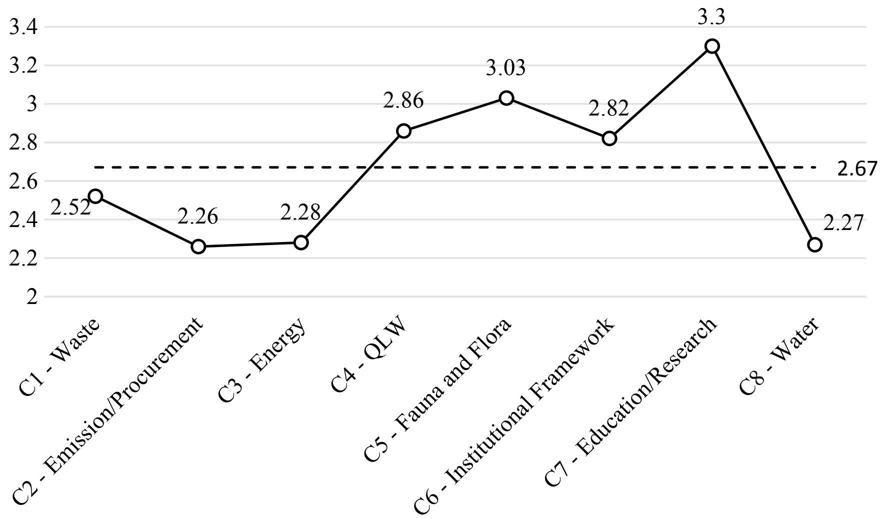

Fig. 3 Score of the Student Perception of HEI's Sustainability (SPHEIS) in each component

2.27). Secondly, students' overall perception of campus sustainability was weak to moderate, with a score of 2.67 (SD = 0.56), as shown in Fig. 3.

This low score obtained in the assessment of the sustainability performance perceived by the surveyed students needs to be considered through the analysis of each of the items that make up the developed scale, by those responsible for the implementation of sustainability practices. In this way, it will be possible to conclude whether the results are due to low investment in some sustainability practices implemented by the institution, or if it is due to a lack of communication channels between the institution and its students that would allow the latter to become aware of institutional efforts towards sustainability.

7 Conclusion and Recommendation

This section offers a concise and comprehensive conclusion of the study's findings. This study was carried out to achieve two main objectives. The first objective was to contribute to the literature by designing a sustainable assessment tool to assess the students' perception of HEI campuses' sustainability, based on a Brazilian HEI case study. This objective was achieved through the development and application of a multi-scale survey, composed of 31 items grouped into eight components that cover the main aspects of campus sustainability as perceived by students. The validation procedure adopted statistical measures to ensure results' consistency and therefore acceptable statistics scores that demonstrate a valid and reliable tool. The proposed instrument would work as a complementary tool to assess HEIs' sustainability performance and assist managers in improving their efforts to increase the students' commitment to building a sustainable HEI which is able to face and accomplish the new society requirements towards sustainable development. Taking into account the performance obtained through the collected data, a gap may exist between the implementation of sustainable practices and their perception by the students. This gap may be overcome with an effort to improve communication towards sustainability practices by using the available social media channels to provide information about achievements pertinent to sustainable development on campus.

The second objective of the study intended to evaluate the adherence of the proposed tool, Student Perception of HEI's Sustainability (SPHEIS), in relation to the dimensions of HEI sustainability designed by Lozano et al. (2015). The proposed tool was partially adherent to the Lozano et al. (2015) model once the eight components of the SPHEIS were related to five dimensions of the Lozano et al. (2015) model. In fact, five of the eight components were found adherent to the Campus operations dimension which are in line with the work of Findler et al. (2018), who analysed 19 SATs and concluded also that the analysed tools include more items focused on Campus operations. Table 2 showed that the highest amount of the analysed items, 34.48%, were grouped into this dimension. A justification for the dimensions Outreach and Assessment and reporting not being considered in the proposed SPHEIS model would be that these two dimensions tend to be less easily perceived by the students, since usually students are more focused on activities related to campus operation, education and research.

Considering the results, implications and recommendations could be designed for university planners and decision-makers to increase sustainability in HEIs and correlated institutions. As an illustration, a few of them are presented below. (1) Future studies may expand the sample and include more items, such as those related to Assessment and reporting as well as Outreach, in order to comply with all dimensions of HEIs' sustainability and to provide results that are more representative. (2) Future research may examine the validity of the introduced assessment tool in another regional context. (3) The assessment tool may be adapted to other correlated institutions, like hospitals or secondary schools, to measure customer/user perception of sustainability. (4) Besides, due to time limitations, this study was applied with a cross-sectional approach, therefore it is suggested for future research to adopt a longitudinal approach as a way to control the sustainability performance and implement the principles of continuous improvement.

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