



Green Campus Initiatives as sustainable development dissemination at higher education institutions: Students' perceptions

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ABSTRACT

Students are future leaders who will be expected to make decisions aimed at achieving sustainability as they take up key roles in education in the area of sustainable development. In this context, Green Campus Initiatives were set up at four Brazilian universities to promote student engagement in finding ways to incorporate sustainability in the way the university operates. This article aims to identify whether the Green Campus Initiatives is a viable strategy for disseminating sustainable development concepts in higher education institutions, enhancing the students' knowledge and proactivity regarding sustainable development. This quantitative-descriptive study was based on data collected in a survey involving students from four Brazilian universities, with a sample of 1013 respondents. The data were analyzed using multivariate statistical techniques. The results show that sustainable development dissemination strategies in higher education institutions explain around 18% of the students' level of proactivity and 27.7% of their knowledge and awareness regarding sustainable development. The findings of this study could aid planning in higher education institutions aimed at implementing environmentally sustainable practices at universities based on student perceptions.

1. Introduction

The dissemination of the concept of sustainable development (SD) occurs through the transfer of information to raise awareness of the need for a balance between the environment, the economy and society. Higher education institutions (HEIs) are central players in this process, acting as a bridge between scientific knowledge and common sense

(Guerra et al., 2018). Achieving sustainability at university campuses has become an issue of worldwide interest, particularly given the increasing force of the pro-sustainability movement (Alshuwaikhat and Abubakar, 2008; Velazquez et al., 2006).

Green Campus Initiatives (GCIs) are being set up at HEIs as a strategy to promote SD. They are focused on implementing sustainable infrastructure, reducing environmental impacts and economic costs, and

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raising student awareness regarding the concept of SD (Patel and Patel, 2012; Chalfoun, 2014; Ribeiro et al., 2017, 2019; Hayder, 2017; Mafongosi et al., 2018). Green Campus Initiatives models encompass HEIs' sustainability initiatives, which are focused on meeting the goals set by the Talloires Declaration and the United Nations Sustainable Development Goals (UN SDGs).

In this context, based on studies by several authors (Freidenfelds et al., 2018; Ribeiro et al., 2017; Nurdiana, 2017; Tan et al., 2017; Guerra et al., 2018; Lauder et al., 2015; Disterheft et al., 2015; Adomɔnt et al., 2014; Saadatian et al., 2013; Hooi et al., 2012; Alshuwaikhat and Abubakar, 2008; Velazquez et al., 2006), GCIs are identified as a dimension of sustainable HEIs, which require interaction between education and awareness (people), buildings/environment (place), and management (processes) at HEI. Interaction between people, processes and place can be achieved based on the Talloires SD guidelines for universities:

- Leadership in planning, implementing and managing sustainability policies;
- Sustainable education and learning;
- The implementation of green technologies within a wide range of campus activities;
- The preservation of the ecosystems at and close to the institution;
- Transdisciplinary studies and outreach programs;
- Cooperation with other universities;
- Development of skills and awareness of those who work with SD activities;
- A campaign to develop cultural awareness and sustainable actions among students.

Higher education institutions are seen as places for preparing future leaders who can explain sustainable management practices to interested parties and decision-makers (Freidenfelds et al., 2018; McMillin and Dyball, 2009). Students and campus staff need to be encouraged to reflect on the values of sustainability and adapt their daily actions to attend sustainability initiatives and objectives. Students can therefore act as ambassadors of the best initiatives in favor of sustainability (Dale and Newman, 2005; Djordjevic and Cotton, 2011; Hooi et al., 2012; Freidenfelds et al., 2018). As stated by Lozano et al. (2013, p. 8), "How can the people in these organizations become more effective role models and change agents within all societies? Fellow educators and students this is our opportunity."

To be a sustainable HEI goes beyond the disclosure of a concept. It implies assimilating the concept into the processes, activities and the daily reality of the organization. Based on the relation between campus users and green initiatives at HEIs, this study seeks to understand how students perceive these initiatives and whether the established goals have effectively been attained. Through the perception of the students, the absorption of pro-sustainability values into the culture of the organizational structure of the institution was evaluated. The overall goal of this research was to identify whether the SD dissemination strategies at universities influence the knowledge and proactivity of the students regarding SD.

Four universities in southern Brazil, in which GCIs have been set up, were the subject of this study. The actions resulting from these GCIs include the following. Energetic efficiency was addressed by replacing conventional lamps with LED lamps and installing presence sensors to activate lights in corridors and rooms. To achieve more efficient water use, rain harvesting systems are being installed in the new buildings, along with cisterns and faucets based on technologies to avoid water waste. Recycling presents a challenge at universities, but all four included in this study have facilities that allow selective waste collection. Another important aspect is the implementation of education for sustainability within the HEI policies. The selection of the four HEIs was based upon the disclosure of their GCI implementation platforms, their focus on research related to sustainability, and their response to federal

legislation that makes these initiatives mandatory.

Through the innovative approach of this study, the aim was to understand the perceptions of university students regarding the GCIs. The findings can aid institutional administrators in formulating policies and programs aimed at efficiently monitoring progress regarding the SD of HEIs, the dissemination of SD concepts to students and the promotion of environmental education and the application of sustainable practices in the broader society.

2. Student perspectives on sustainable HEIs

University campuses play an important role in educating future generations on concepts related to sustainability. Although there is no single model for the operation of a 'green' campus, in this context the term "greening" refers to actions aimed at minimizing adverse socio-environmental impacts (Ribeiro et al., 2017; Huang et al., 2015; Alshuwaikhat and Abubakar, 2008). The actions resulting from GCIs can be divided into different categories depending on the expected result. These categories are mainly related to the maintenance of the university resources and minimizing negative impacts at the socio-environmental and economic levels.

The actions aimed at achieving a green infrastructure in university campuses have been referred to as GCIs by several authors (Patel and Patel, 2012; Chalfoun, 2014; Ribeiro et al., 2017, 2019; Hayder, 2017; Mafongosi et al., 2018). Based on the literature, some categories of GCIs can be defined (Mafongosi et al., 2018; Ribeiro et al., 2017; Saleh et al., 2011; Patel and Patel, 2012; Alshuwaikhat and Abubakar, 2008; Roy et al., 2008). In this study, the following categories were considered: clean energy, energy efficiency, water efficiency, waste management, sustainable transport, education for SD.

Green Campus Initiatives are related to education on SD and the implementation of green infrastructures on university campuses, aimed at reducing the carbon footprint of the HEI while raising the awareness of students regarding attitudes toward sustainability, as shown in Table 1. In this regard, university campuses are living laboratories, full of opportunities for promoting sustainable learning and awareness. Table 1 shows the categories considered herein, provides details of their main characteristics and cites the authors of the publications used as references.

The term "greening" herein refers to an environmental management system for the higher education sector. It is an integrated and comprehensive concept aimed at educating society's future leaders in subjects related to protecting the environment (Moelyaningrum and Ningrum, 2017). As the cradle of education of future leaders, universities must meet the need for student training, taking full advantage of the opportunities arising from sustainability projects (Arbuthnott, 2009; McMillin and Dyball, 2009; Geng et al., 2013). This need became clear in a comparative study by Dagiliūtė et al. (2018) on the perceptions of students at green and non-green universities. The results showed that students from a green university are more proactive and better understand the concepts of SD.

Therefore, the most crucial factor for any new implementation of campus greening systems is to create a culture of engagement and acceptance among the users. The GCIs should be implemented in a planned way, rather than with an "impulse-oriented" improvised approach that may hinder students' understanding of the central idea of SD initiatives (Wisecup et al., 2017). Student disposition is critical to the success of GCIs. Lozano et al. (2013) suggested that HEIs can contribute to the necessary cultural changes by disseminating current approaches to sustainability. Such ideas need to link theory and practice and managers need to interact with users in a multidimensional approach, so that sustainability is integrated throughout the university system (Perrault and Clark, 2017).

According to Kamp (2006), Nicolaidis (2006) and Mulder (2006), to achieve the SD of HEIs, the campus users need to be aware that: (i) the use of renewable resources and circular economy play a critical role; (ii)

Table 1
Categories of Green Campus Initiatives considered in this study.

Categories	Characteristics	Authors
Education on SD	Number of students, professors and administration staff, number of courses offered, resources allocated for research on environment and sustainability, number of academic publications on environment and sustainability, number of academic events on environment and sustainability, number of organizations related to the environment and sustainability and information on sustainability on the university website.	Velazquez et al. (2006); Arbuthnott (2009); Hayder et al. (2017); Ribeiro et al. (2017); Ribeiro et al. (2019); Guerra et al. (2018); De Lozado et al. (2013); Tan et al. (2014); Hooi et al. (2012); Djordjevic and Cotton (2011); Suwartha and Sari (2013)
Clean Energy	Renewable energy use policy, energy conservation program, sustainable buildings, adaptation to climate change and mitigation program, policy to reduce greenhouse gas emissions, and percentage of campus area covered in forest-like vegetation.	Kamp (2006); Nicolaides (2006); Mulder (2006); Ribeiro et al., (2017); Guerra et al., (2018); Suwartha and Sari (2013)
Energy Efficiency	Use of energy-efficient appliances, building retrofit, promoting better lighting, ventilation, air quality and temperature control, reducing dangerous air-pollutants that cause respiratory diseases.	Kamp (2006); Nicolaides (2006); Mulder (2006); Ribeiro et al., (2017); Guerra et al., (2018); Suwartha and Sari (2013)
Waste Management	University waste recycling program, toxic waste recycling, organic waste treatment, inorganic waste treatment, sewage disposal.	Ribeiro et al., (2017); Suwartha and Sari (2013); Guerra et al., (2018); Kagawa (2007); Chaplin and Wyton (2014); Lukman and Glavič, 2007
Water Efficiency	Water conservation program. Rainwater harvesting for use in irrigation and landscapes, resistant plants, water reuse, technologies to reduce waste.	Ribeiro et al., (2017); Suwartha and Sari (2013); Guerra et al., (2018); Fahrianto et al., (2018); Mafongosi et al., (2018); Kagawa (2007); Chaplin and Wyton (2014)
Sustainable Transport	Transportation policy to limit the number of motor vehicles used on campus and limit (or decrease) the campus parking area and extend campus bus service and bicycle/pedestrian infrastructure.	Ribeiro et al., (2017); Suwartha and Sari (2013); Guerra et al., (2018)

SD is connected to the broader social context; and (iii) a share of the financial savings should be converted into actions that contribute to society. Providing clear information regarding the above three points is important since many students do not fully understand the concepts associated with sustainability practices (Hayder, 2017).

Tan et al. (2014) noted that some difficulties and obstacles, such as mismanagement and lack of interest, related to the implementation of sustainable initiatives at HEIs are becoming better understood. According to the results obtained from a study by Leal Filho et al. (2017), obstacles undermined the development of sustainability programs in universities and, consequently, the opportunities available for students decreased. Management areas pose the greatest obstacles to SD in HEIs. This is followed by a lack of interest or concern related to sustainability issues on the part of the professionals who act in the management of public or private organizations. A lack of structured groups, such as environmental committees, also contributes to the problem.

Ferrer-Balas et al. (2008) considered that the main barrier to overcome is the lack of a structure to provide incentives aimed at promoting change at the individual level, involving the students directly. Individual efforts have gradually transformed sustainable ideas into reality at universities (Helferty and Clarke, 2009). Lukman and Glavič (2007) noted that the bottom-up approach is more appropriate for the implementation of SD at HEIs. The authors emphasized that this process was successful due to the university student council involvement: "It is important to note that students are difficult to organize, but easier to motivate." (Lukman and Glavič, 2007, p. 112).

Several studies concluded that students consider SD essential but do not consider themselves familiar with its concept, and there seems to be a gap between the valorization of sustainability and putting it into action (Kagawa, 2007; Lourdel et al., 2007; Savageau, 2013; Chaplin and Wyton, 2014; Zwickle et al., 2014; Perrault and Clark, 2017; Dagiliūtė et al., 2018; Ribeiro et al., 2019). It can be challenging for students to associate SD concepts and social aspects (Lourdel et al., 2007; Ribeiro et al., 2019; Rampasso et al., 2019). Students are more likely to take sustainable actions when reflecting on their responsibilities as consumers, such as changing purchasing habits, recycling, and saving energy or water (Kagawa, 2007; Chaplin and Wyton, 2014). At the same time, HEIs did not consider students' expectations, and it is necessary to provide them with the opportunity to participate in sustainability efforts (Tezel et al., 2018).

The important role of students in SD is highlighted in these studies, and it has been demonstrated that they are considered stakeholders who can participate in proposing actions to be taken at HEIs (Schoeps and

Hemmer, 2018). Students can be project leaders on campus and in the surrounding community, as they are local witnesses of the situations and can propose practical solutions to the challenges encountered (Bacon et al., 2011). Therefore, future generations will take advantage of sustainable initiatives (Alshuwaikhat and Abubakar, 2008). Nevertheless, their engagement in pro-sustainability actions remains low (Savelyeva and Douglas, 2017).

In this context, complex SD issues have to be recognized and increased interdisciplinary thinking, systemic thinking for cooperative work, communication skills, and knowledge application to sustainability can aid a systemic approach to address these issues (Dobson and Tomkinson, 2012; Jarchow et al., 2018; Murray, 2018). This could result in students adopting appropriate values, attitudes and behaviors aimed at achieving environmental sustainability (Nejati and Nejati, 2013).

This goal could be achieved through the incorporation of sustainability initiatives through conferences, seminars and workshops (Lauder et al., 2015; Tan et al., 2014; Velazquez et al., 2006; Djordjevic and Cotton, 2011; Alshuwaikhat and Abubakar, 2008), including sustainability as a subject in courses and curricula (Guerra et al., 2018; de Lozano et al., 2013; Tan et al., 2014; Hooi et al., 2012; Djordjevic and Cotton, 2011; Velazquez et al., 2006) and extending research and development in this area (Tan et al., 2014; Hooi et al., 2012; Alshuwaikhat and Abubakar, 2008). Additionally, Velazquez et al. (2006) and Katiliute and Daunoriene (2015) pointed out the possibilities for dissemination through internet channels with interaction between the HEIs and campus users.

The concept of a Green Campus (GC) is holistic, where environmental awareness and action become an integral part of the daily activities at HEIs. A GC can be achieved through implementing GCIs, which focus on the environmental, economic and social issues of HEIs. Much more than a portfolio of projects and programs related to environmental issues, the GCIs should lie at the center of all activities on the university campus (Goodwin and Wright, 2013). Sustainability awareness arises from campus-based green initiatives focused on student participation in training leaders to develop other sustainable programs in society. These joint initiatives can promote the dissemination of SD beyond the HEI campuses. The leaders should be democratic, participatory and honest and they should mirror the university management models to foster the promotion of SD in society.

2.1. Research framework

The sustainable university model should provide a clear perspective

on how people are responsible for sustainability initiatives. A sustainable university is recognized by the connection between sustainability initiatives and teaching, research, outreach and other campus structures (Velazquez et al., 2006). The cited authors argued that HEIs should have departments coordinating communication and the supply of resources among the various sustainability initiatives on their campus. These activities would promote the dissemination of related information while ensuring the monitoring of the awareness of those involved.

Lukman and Glavič (2007) highlighted the importance of SD and the search for strategic elements that lead to the successful greening of universities. Higher education institutions should rely on continuous feedback (communication) from campus users (students) to incorporate sustainability principles into university activities, linking this to research, outreach, and teaching, and promoting activities such as workshops and lectures. Alshuwaikhat and Abubakar (2008) related teaching to raised awareness of SD concepts, via effective communication, stressing the value of sustainability to the university and society as a whole. Suwartha and Sari (2013) noted that, in 2010, Universitas Indonesia developed the UI GreenMetric World University Rankings to provide a profile and compare the levels of commitment of universities to becoming environmentally friendly and promoting sustainable operations, considering three critical dimensions: research, education and the environment.

In addition, Nejati and Nejati (2013) demonstrated that the development of environmentally sustainable campus infrastructures raises awareness of SC concepts. The overall success of HEIs was found to be related to teaching approaches and programs that involved green initiatives on campus. The success of GCI is dependent on long-term strategic planning. According to Tan et al. (2014), in tandem with educational campaigns, pilot infrastructure projects need to be focused on sensitizing students to sustainability issues, which is one of the main factors that can lead to a GC.

Methods for the dissemination of SD concepts are intertwined with ideas regarding participation strategies, according to a study by Disterheft et al. (2015), which are associated with the perspectives of ethical and social learning stemming from the involvement of campus users. According to the cited authors, communication should allow the joint development of a strategy with clear and tangible objectives with which the participants relate. Guerra et al. (2018) developed a Balanced Scorecard strategy map to create and monitor environmental education programs, linking the importance of education management to promoting SD among campus users. In their study, Godfrey and Feng (2017), Ribeiro et al. (2017), and Dagiliūtė et al. (2018) supported the rationale of Disterheft et al. (2015), seeing communication as a good strategy for raising the awareness of SD concepts, and suggesting that control over the process of transmitting information, which is often neglected, must be fostered. Also, in a study conducted by Fahrianto et al. (2018), it was concluded that GCIs create awareness through promoting efficient resource use, such as energy efficiency management.

According to Velazquez et al. (2006), the aim of GCIs is to raise sustainability awareness among people participating in their implementation, and promoting the SD of the campus, for instance, through the use of technology that reduces environmental impact, helps students change their behavior, directing it these toward sustainability. Lukman and Glavič (2007) consider that research, outreach, lectures and workshops related to SD could motivate lifestyles changes in campus users. To ensure a culture that values sustainability practices, long-term campus planning requires the community's participation. Universities must emphasize the importance of having a sustainable campus by creating learning environments that promote awareness of the benefits of sustainable practices (Alshuwaikhat and Abubakar, 2008).

Large campuses resemble small towns in terms of population and economic, socio-cultural and political interactions. Based on this relation, Saadatian et al. (2013) advocated that initiatives should make university students aware of responsible social actions and the need to protect the environment, nourishing a sense of community. Research by

Nejati and Nejati (2013) indicated that, in addition to outreach programs, the university should encourage on-campus research and compile a summary of possible challenges related to student practices that may be encountered during their implementation.

Dissemination and participation contribute to the ethical and social learning perspectives of campus users. Communication should allow the development of a strategy with clear and tangible objectives to which the participants relate. In general, the process should be focused on training and empowerment, allowing the various activities to be performed on campus and in society in general (Disterheft et al., 2015). Additionally, Ribeiro et al. (2017) pointed out that communication includes establishing fixed campus routines, mainly related to the most efficient practices associated with the sustainability initiatives. Leaflets, posters, websites, campus newspapers, faculty members and administrative staff are information providers able to raise student awareness (Dagiliūtė et al., 2018).

With regard to sustainable campus infrastructures, Ribeiro et al. (2017) considered them laboratories to develop their skills and put into practice their knowledge related to SD. They encouraged users to separate waste, save water and energy, use sustainable transportation and promote social development. Hayder et al. (2017) indicated that the students' knowledge and willingness to participate in green activities can reduce greenhouse gas emissions. However, while there is some awareness among students regarding sustainability practices, many are still not adhering strictly to them. With green initiatives being implemented on campus, more practical encouragement and campaigns could be explored and conducted at universities. Table 2 summarizes the variables associated with achieving the SD goals and the relevant references, divided into four independent variables (SD in Class; SD outside

Table 2
Summary of variables supported by authors.

Independent Variables	Dependent Variables	Authors
SD in Class	SD Knowledge	Alshuwaikhat and Abubakar (2008) Lukman and Glavič (2007) Disterheft et al. (2015)
	SD Proactivity	Alshuwaikhat and Abubakar (2008) Guerra et al. (2018) Disterheft et al. (2015)
SD outside Class	SD Knowledge	Lukman and Glavič (2007) Disterheft et al. (2015) Suwartha and Sari (2013)
	SD Proactivity	Lukman and Glavič (2007) Saadatian et al. (2013) Nejati and Nejati (2013)
SD Communication	SD Knowledge	Alshuwaikhat and Abubakar (2008) Velazquez et al. (2006) Godfrey and Feng (2017) Ribeiro et al. (2017)
	SD Proactivity	Disterheft et al. (2015) Perrault and Clark (2017) Ribeiro et al. (2017) Dagiliūtė et al. (2018)
Infrastructure for SD	SD Knowledge	Fahrianto et al. (2018) Nejati and Nejati (2013) Tan et al. (2014)
	SD Proactivity	Ribeiro et al. (2017) Saadatian et al. (2013) Velazquez et al. (2006) Hayder et al. (2017)
Control Variables – Student Profile Gender, Age group, Graduation in environmental fields, Employment, Time at university, Course level, Monthly Family Income		Hair et al. (2010), Malhotra (2012)

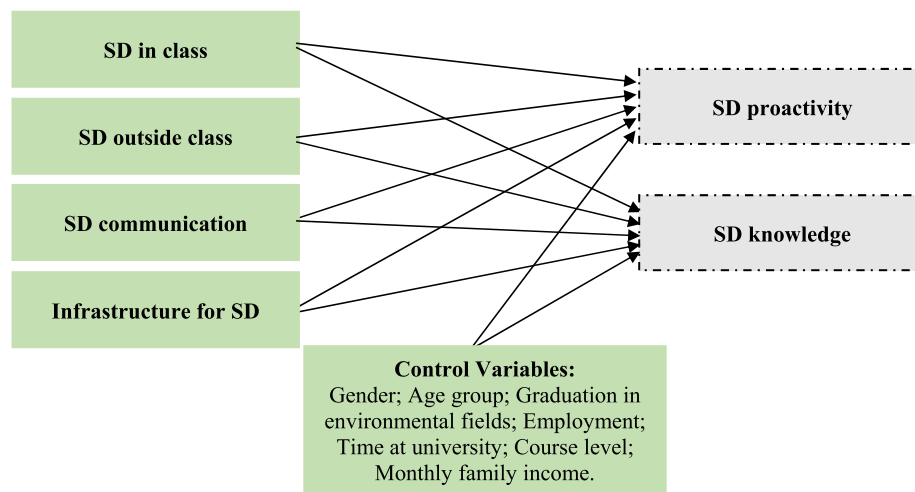


Fig. 1. Research framework.

Class; Communication in SD; Infrastructure for SD), and two dependent variables (SD Knowledge and SD Proactivity). The control variables, used to obtain details on the characteristics of the students (gender, age, course level, time at university and income), are also included in Table 2. These are used, as recommended by Hair et al. (2010) and Malhotra (2012), to analyze the differences in students' profiles.

Based on the construct of the strategies for disseminating SD concepts in universities and the respondents' profile, a research framework was developed to show the proposed relations in this study. Table 2 shows the relationships of the variables and the associated references while Fig. 1 represents the research framework, with the dependent, independent and control variables.

Fig. 1 shows the influence of the control variables, SD addressed in class (SD in class), extracurricular activities regarding SD (SD outside class), SD communication (SD communication), and green infrastructure at university campuses (Infrastructure for SD), on the level of knowledge and awareness regarding SD (SD Knowledge) and level of proactivity regarding SD (SD Proactivity) variables.

3. Methods: information on population and sample, data collection and analysis

Four universities located in the state of Santa Catarina, Brazil, were chosen for this study. These HEIs play an important social role in the region, fostering SD and involving industrial entities and government. According to the literature review executed in this study, these four universities have taken innovated action over the last ten years by carrying out GCIs. A preliminary analysis observed that the four universities had similar GCIs, addressing issues such as renewable energy, energy and water efficiency, environmental education and waste management. Thus, the four universities were analyzed in an aggregated manner.

This study was predominantly quantitative. Data was collected from students at the selected universities and the sampling (student selection) was non-probabilistic for convenience (Malhotra, 2012). The questionnaire was sent online to the students and 1013 responses were collected: 302 from University A, 188 from University B, 217 from University C and 306 from University D. The questionnaire sent online was shared in the social media and presented at the universities during the course recess.

A set of 27 prompts were compiled based on a synthesis of prior research (see Table 2). Participants were given the prompts and asked to rate their agreement to them using a Likert scale. The questionnaire was divided into six blocks representing different strategies of HEIs related to SD. These blocks formed the research construct, as shown in Table 3.

The responses to the prompts were measured using a Likert scale, which varied from 1 for "totally disagree" to 5 for "totally agree." The prompts were designed to give a better understand of the student perceptions of the GCIs implemented by HEIs. The indicators measured from the statements can suffer bias due to the students' perception of SDs. The prompts were divided into blocks which, formed the variables used in the multivariate model employing multiple linear regressions. The results for the average value obtained for each block (SD Knowledge; SD Proactivity; SD in the Class; SD outside Class; SD Communication; and Infrastructure for SD) were the variables used in the model. Finally, the profiles of the respondents were used to identify whether individual attributes can also affect student perceptions regarding SD. Therefore, information was collected regarding gender, age, course level, employment, time at the university, course level (undergraduate, graduate, i.e., master's and doctoral, or postdoctoral studies) and family income. The regression equations used in this study were obtained from the relevant literature. Equation (1) seeks to ascertain the effect of SD in Class, SD outside Class, SD Communication, and Infrastructure for SD. Finally, the respondents' profile to identify whether individual attributes can also affect students' perceptions about SD. Therefore, information was collected regarding gender, age, education level, employment, time spent at the university, course level (undergraduate or graduate studies, MBA, master, doctoral, postdoctoral), and family income.

Equation 1¹

$$\begin{aligned} \text{SD Knowledge} = & \beta_0 + \beta_1 \text{SD in Class} + \beta_2 \text{SD outside Class} \\ & + \beta_3 \text{SD Communication} + \beta_4 \text{Infrastructure for SD} \\ & + \beta_5 \text{Control Variables} + \varepsilon \end{aligned}$$

Equation (2) identifies the effect of SD in Class, SD outside Class, SD Communication, and Infrastructure for SD on SD Proactivity of the students.

¹ SD Knowledge = Level of knowledge and awareness regarding SD; SD in Class = Level of SD addressed in Class; SD outside Class = Extracurricular class activities regarding SD; SD communication = Sustainable development communication; Infrastructure for SD = Green infrastructure on university campuses; Control variables = Control variables comprising the following individual attributes: Gender (Gen.); Age group (Age); graduation in environmental studies (Grad. Env.); employment (Emp.); Time at university (semesters); course level (Level); monthly family income (Income).

Table 3

Construct of the strategies for dissemination of SD concepts in universities.

Dependent Variables	Prompts	Abbreviation	Authors
Level of knowledge and awareness regarding SD (SD Knowledge)	I have knowledge of SD; I seek information related to SD; I know the objectives of SD (ODS); I consider SD important for society, the environment and the economy.	PCDS IDS PODS DSSAE	Velazquez et al. (2006); Lukman and Glavič (2007); Ferrer-Balas et al. (2008); Alshuwaikhat and Abubakar (2008); Hooi et al. (2012); Nejati and Nejati (2013); Adomɔnt et al. (2014); Hancock and Nuttman (2014); Wright and Wilton (2012); Katiliute and Daunoriene (2015); Lauder et al. (2015); Guerra et al. (2018).
Level of proactivity regarding SD (SD Proactivity)	Pro-sustainability initiatives related to sorting waste are included in my day-to-day activities Pro-sustainability initiatives related to saving electricity are included in my day-to-day activities Pro-sustainability initiatives related to using sustainable transport (bicycle, public transport, car-pooling) are included in my day-to-day activities Pro-sustainability initiatives related to saving water are included in my day-to-day activities Pro-sustainability initiatives related to doing social work are included in my day-to-day activities I participate in events or activities in support of sustainability.	ISSL ISEE ISTA ISEA ISTS EPS	Velazquez et al. (2006); Suwartha and Sari (2013); Saadatian et al. (2013); Alshuwaikhat and Abubakar (2008); Suwartha and Sari (2013); Tan et al. (2014); Hancock and Nuttman (2014); Lauder et al. (2015); Fahrianto et al. (2018); Mafongosi et al. (2018); Dagiliūtė et al. (2018); Guerra et al. (2018).
Independent Variables	Prompts	Abbreviation	Authors
Level of SD addressed in class	Universities are important for promoting SD At least once every semester I have activities in the classroom related to economic, environmental and/or social sustainability Teachers usually address SD subjects during their classes The university where I study promotes pro-SD actions	UPDS ASEAS PADS UPADS	Velazquez et al. (2006); Lukman and Glavič (2007); Alshuwaikhat and Abubakar (2008); Djordjevic and Cotton (2011); Hooi et al. (2012); Tan et al. (2014); Nejati and Nejati (2013); Wright and Wilton (2012); Katiliute and Daunoriene (2015); Lauder et al. (2015); Mafongosi et al. (2018); Guerra et al. (2018).
Extracurricular class activities regarding SD (SD outside Class)	My university promotes research activities related to SD My university promotes outreach activities related to SD My university promotes quizzes/challenges/games related to SD; My university promotes lectures on SD My university promotes workshops on SD	PPDS PEDS PGDS PPADS PWDS	Velazquez et al. (2006); Lukman and Glavič (2007); Alshuwaikhat and Abubakar (2008); Djordjevic and Cotton (2011); Hooi et al. (2012); Nejati and Nejati (2013); Tan et al. (2014); Lauder et al. (2015); Guerra et al. (2018); Aleixo et al. (2018).
SD Communication	There is communication in my university that helps promote SD My university clarifies my doubts and questions regarding SD.	CUPDS URDDS	Velazquez et al. (2006); Alshuwaikhat and Abubakar (2008); Hooi et al. (2012); Katiliute and Daunoriene (2015); Perrault and Clark (2017); Disterheft et al. (2015); Godfrey and Feng (2017); Perrault and Clark (2017); Ribeiro et al. (2017); Dagiliūtė et al. (2018); Guerra et al. (2018).
Green infrastructure on university campuses (Infrastructure for SD)	I consider the campus (university infrastructure) to adhere to sustainability concepts My university takes action to promote the use of renewable energies My university takes action to promote energy efficiency; My university takes action to promote water efficiency; My university takes action to promote waste management; My university to promote sustainable transport (bicycle, public transport, and car-pooling, among others).	IUS AUER AUER AUEH AUGR AUTS	Velazquez et al. (2006); Alshuwaikhat and Abubakar (2008); Hooi et al. (2012); Suwartha and Sari (2013); Tan et al. (2014); Nejati and Nejati (2013); Saadatian et al. (2013); Nejati and Nejati (2013); Hancock and Nuttman (2014); Lauder et al. (2015); Ribeiro et al. (2017); Fahrianto et al. (2018); Mafongosi et al. (2018); Guerra et al. (2018).

Equation 2²

$$\text{SD Proactivity} = \beta_0 + \beta_1 \text{SD in Class} + \beta_2 \text{SD outside Class} + \beta_3 \text{SD Communication} + \beta_4 \text{Infrastructure for SD} + \beta_5 \text{Control Variables} + \varepsilon$$

Data analysis was performed using multiple linear regression in SPSS software, version 24. The results are presented in the next section.

4. Results

This section presents the research findings based on relevant data obtained by the authors. The results in this section of the article are divided into two categories: from descriptive statistics and from multivariate statistics.

4.1. Results obtained from descriptive statistics

The descriptive statistics regarding the profiles of the respondents are given in Table 4. Data on gender, age, employment, time at

university, course level and family income are shown below.

The research results demonstrate a predominance of males, aged 15 to 25, who did not study in the environmental field, with employment and monthly family income (US\$) between 248 and 743. Most students had completed 1–6 semesters at university with a large proportion being undergraduates. Table 5 shows the internal consistency in the responses of all groups for the prompts from the construct of strategies for disseminating SD concepts in universities, according to Cronbach's alpha value.

Based on Table 5, it was observed that the construct presented internal consistency in all groups of the established variables: 'Substantial' consistency was obtained to a lesser extent, and the 'Almost Perfect' consistency to a greater extent. Table 6 shows the descriptive statistics (mean, and standard deviation (Std. Dev.)) related to the strategy for disseminating SD concepts in universities, using a Likert scale of 5 points.

Table 6 shows the descriptive statistics (mean and standard deviation) for the construct and the variables analyzed. The table contains the six constructs (SD knowledge, SD proactivity, SD in the class, SD outside class, SD communication, and infrastructure for SD) and the twenty-seven prompts. The goal is to identify the perceptions of the students for each prompt and to analyze the construct in general.

It can be observed that the average response values in Table 6

² SD Proactivity = Level of proactivity regarding SD (see Footnote 1).

decrease from the first group of prompts (SD Knowledge) to the last group of prompts (Infrastructure for SD). We can infer that the construct of this research initially addresses issues of a personal context, which involve the level of knowledge and the proactivity of individuals concerning SD actions. Subsequently, the prompts focus on the attitude of the educational institution toward actions aimed at SD. Lastly, aspects of the local infrastructure are addressed considering SD actions related to communication and the physical structure of the university.

The tendency for the average response values to decrease from the first to the last group of prompts in the construct is consistent with the findings of Cendón et al. (2014). According to the cited authors, respondents tend to overestimate issues related to their personal context, evaluating less favorably institutional aspects of their environment followed by infrastructure aspects (Cendón et al., 2014). Thus, the responses obtained in a survey may vary, in terms of the average values of the scales, according to the nature of the prompts (Chaer et al., 2011; Dalmoro and Vieira, 2013). Limitations of this study may therefore be related to applying the prompts without randomization and also the length of the questionnaire that may have caused fatigue on the part of the respondents.

4.2. Results of the impact of sustainable development dissemination strategies in universities on students' initiatives and knowledge

Firstly, it should be noted that in the development of multiple linear regression models asymptotic normality is assumed. Based on the central limit theorem, as the sample size of a distribution increases it approaches normality. Thus, in most cases, for a convenient sample size, it can be assumed that the variables have an approximately normal distribution and the usual methods of analysis can be adopted (Hoeffding and Robbins, 1948; Saunders, 2011; Sweeney et al., 2013).

Table 7 shows the models representing the influence of the strategies for the dissemination of SD concepts in HEIs related to SD Knowledge and SD Proactivity. These two variables show statistical significance (see *ModelSig*), with SD Knowledge having an explanatory power (r^2) of 27.7% and SD Proactivity having an explanatory power (r^2) of 18.6%. Of the measured independent variables, for SD Knowledge only one was not statistically significant (course level = 0.272) while for SD Proactivity several independent variables were not statistically significant.

Next, we sought to identify the individual influence of the issues addressed in the dissemination strategies for SD on the SD Knowledge, as seen in Table 8. It can be observed that all independent variables analyzed have statistical significance when related to SD Knowledge. In the case of SD Infrastructure for SD, with the exception of AUTS (0.047), the variables did not show statistical significance for most prompts. Table 7 also gives the explanatory power of each relationship through r^2 .

The study identified the prompts of individual influence that compose the variables of SD dissemination strategies regarding the SD Proactivity, as shown in Table 9. The explanatory power of the model generated is also shown through r^2 , with a significance value (*ModelSig*) of 0.000 (SD in Class = 15.4; SD outside Class = 9.6; SD Communication = 9.7; Infrastructure for SD = 8.9). All independent variables are statistically significant when analyzed with the dependent variable (SD Proactivity). The prompts in the Infrastructure for SD construct present less statistical significance and less explanatory power.

5. Discussion

The data collected in this study are discussed in the following sections. In general, the results indicate that the university students have an excellent recognition of SD, promoted by addressing the themes in the classroom and outside the classroom at universities. However, green infrastructure on campuses is less evident in students' perceptions. These findings suggest that universities with infrastructure initiatives for SD communicate their actions more efficiently. This communication is vital for students to connect teaching with the university's commitment

to SD practices.

5.1. Descriptive data analysis

The results reported in Table 6 are analyzed in this section. Firstly, based on the results for level of knowledge and awareness regarding SD (SD Knowledge), the students appear to consider SD important (DSSAE mean = 4.57) and it is thus surprising that they do not delve deeper into the theme (IDS mean = 2.83). A possible explanation for that is that information that reaches students only has a learning effect but does not alter their behavior. As Savageau (2013) demonstrated, students are unaware of the effect of their daily actions on the environment and society. Therefore, they consider SD to be meaningful because they have learned this, but they do not seem to be aware of its impacts on the environment, economy, and society. The level of proactivity regarding SD reinforces this understanding. The findings indicate that the students seek to save energy (ISEE mean = 3.96) and water (ISEA mean = 3.98). On the other hand, there is low adherence to the daily initiatives to carry out social work (ISTS mean = 2.62) and participation in events or activities related to sustainability (EPS- mean = 2.30).

Ribeiro et al. (2019) explained that students, in general, tend to make sustainable decisions from a utilitarian view. We can understand that the students favor sustainability initiatives and practices from which they benefit, i.e., saving resources by wasting less electrical energy and water. When we compare this with activities that involve sustainability in the social sphere, it is noted that social activities are even less frequent, and a similar result was found by Rampasso et al. (2019). These results demonstrate that most approaches to SD focus on associating the concept with only environmental issues. There is a need to expand students' awareness of the social sphere, especially in developing countries. In this regard, the UN SDGs should be addressed across the board in the HEI curriculum.

The students' perceptions of SD in Class demonstrated that they realize the importance of universities promoting SD. On the other hand, students did not consider that activities taking place at least once during the semester are related to economic, environmental and social sustainability. It is thus possible that HEIs have not addressed SD in the classroom or the approach has not been effective. Thus, the method of disseminating knowledge and information on SD should be reviewed at the HEIs analyzed. Several studies have been aimed at building practical approaches to the SD agenda and realistic actions are commonly cited.

The involvement of HEIs in promoting activities and discussions on SD outside the classroom (SD outside Class) and students' involvement in economic, environmental and social sustainability classes can help develop awareness of SD in individuals. However, the results demonstrate low participation of the students in activities related to SD performed outside the classroom (mean = 2.87). On the other hand, the results reveal that students perceive that the universities are promoting research activities on SD, corroborating with the findings of Lukman and Glavič (2007), Suwartha and Sari (2013), Disterheft et al. (2015), and Guerra et al. (2018). It was identified that the HEIs are involved in knowledge generation and enhancing awareness related to SD, showing that research is an essential tool for this purpose. Based on their results, Ribeiro et al. (2020) suggest that students consider SD necessary but believe that the solution does not lie in changing behavior but in developing technologies that will reduce human impact on the environment. The observed students' perception of research in HEIs could be related to the findings of Ribeiro et al. (2020).

Out-of-class activities are used to present content related to SD and are associated with two other variables: communication (SD Communication) and green infrastructure (Infrastructure for SD). Communication is essential in disseminating SD concepts and can involve different means to conveying a message. In relation to the prompts related to SD Communication, the mean values (mean = 2.79) are very low and thus communication plans developed by the HEIs do not appear to be having the expected effect.

Table 4

Descriptive statistics of control variables.

Control Variables	Category	Frequency	Percentage
Gender (Gen.)	Female	662	65%
	Male	351	35%
Age group (Age)	15–25 years old	764	75%
	26–35 years old	169	17%
	36–45 years old	56	6%
	46–55 years old	19	2%
	Over 55 years old	5	1%
Graduation in environmental fields (Grad. Env.)	No	982	97%
	Yes	31	3%
Employment (Emp.)	No	358	35%
	Yes	655	65%
Time at university (semester)	1 to 3 semesters	317	31%
	4 to 6 semesters	357	35%
	7 to 9 semesters	194	19%
	Over 9 semesters	145	14%
Course level (Level)	Undergraduate	919	90%
	Specialization	40	4%
	Master's degree	45	4%
	Doctoral degree	05	1%
	Post-doctoral	04	1%
Monthly family income in (US\$) (Income)	Up to \$ 248	88	9%
	Over \$ 248 to \$ 743	382	38%
	Over \$ 743 to \$ 1238	230	23%
	Over \$ 1238 to \$ 1733	135	13%
	Over \$ 1733	178	18%

Table 5

Cronbach's alpha value for internal consistency of the construct of strategies for dissemination of SD concepts in universities.

Metric Variables	Cronbach's alpha value	Number of prompts	Internal consistency
SD outside Class	0.890	5	Almost Perfect
Infrastructure for SD	0.877	6	Almost Perfect
SD in Class	0.777	4	Substantial
SD Knowledge	0.761	4	Substantial
SD Communication	0.741	2	Substantial
SD Proactivity	0.736	6	Substantial

The consequences of students not being informed about sustainable initiatives on campus can impact SD outside Class and Infrastructure for SD (mean = 2.73). Students seem to overlook the infrastructure initiatives on campus (IUS mean = 2.97). Nevertheless, we observed that the highest mean value for this variable was related to developing actions to promote waste management (AUGR mean = 3.13). It should be noted that waste disposal is an activity carried out directly by the students, with effective visual aids and communication used by the universities (via information boards, colored waste containers and campaigns).

This activity is different from initiatives that do not directly relate to the student, such as the use of renewable energies (mean = 2.66), which are mostly addressed by students involved in specific research projects. A more in-depth discussion on the data analysis is given in the next section, based on the information presented, addressing the relationships between dependent and independent variables.

5.2. Multivariate data analysis

The results in Table 7 indicate that the results for the SD study carried out at HEIs can be attributed to SD Knowledge (27.7%) and SD proactivity (18.6%) (ModelSig. = 0.000). Specifically, it appears that SD in Class positively influences the students' SD Knowledge. The results indicate that the HEIs are involved in promoting discussions on SD and SD activities, and the educators are teaching classes on economic,

Table 6

Mean and standard deviation of the 27 Likert scale prompts related to the strategies for dissemination of SD concepts in universities (in Likert Scale) (n = 1013).

Dependent Variables	Mean	Std. Dev.
Level of knowledge and awareness regarding SD (SD Knowledge)	3.45	0.85
I have knowledge of SD (PCDS)	3.56	0.99
I seek information related to SD (IDS)	2.84	1.20
I know the objectives of SD (PODS)	2.84	1.35
I consider SD important for society, the environment and the economy (DSSAE)	4.57	0.86
Level of proactivity regarding SD (SD Proactivity)	3.32	0.81
Pro-sustainability initiatives related to sorting waste are included in my day-to-day activities (ISSL)	3.87	1.22
Pro-Sustainability initiatives related to saving electricity are included in my day-to-day activities (ISEE)	3.97	1.04
Pro-Sustainability initiatives related to using sustainable transport are included in my day-to-day activities (ISTA)	3.18	1.49
Pro-Sustainability initiatives related to saving water are included in my day-to-day activities (ISEA)	3.99	1.03
I have pro-Sustainability initiatives related to doing social work are included in my day-to-day activities (ISTS)	2.63	1.32
I participate in events or activities in support of sustainability (EPS)	2.30	1.27
Independent Variables	Mean	Std. Dev.
Level of SD addressed in Class (SD in Class)	3.15	0.97
Universities are important for promoting SD (UPDS)	4.37	0.94
At least once every semester I have activities in the classroom related to economic, environmental and/or social sustainability (ASEAS)	2.43	1.44
Teachers usually address SD subjects during their classes (PADS)	2.68	1.33
The university where I study promotes pro-SD actions (UPADS)	3.12	1.25
Extracurricular class activities regarding SD (SD outside Class)	2.87	1.06
My university promotes research activities related to SD (PPDS)	3.30	1.30
My university promotes outreach activities related to SD (PEDS)	3.11	1.29
My university promotes quizzes/challenges/games related to SD (PGDS)	2.26	1.24
My university promotes lectures on SD (PPADS)	3.07	1.31
My university promotes workshops on SD (PWDS)	2.63	1.26
SD Communication	2.79	1.12
There is communication in my university that helps promote SD (CUPDS)	2.77	1.27
My university clarifies my doubts and questions regarding SD (URDDS)	2.82	1.25
Green infrastructure on university campuses (Infrastructure for SD)	2.74	1.01
I consider the campus (university infrastructure) to adhere to sustainability concepts (IUS)	2.97	1.20
My university takes action to promote the use of renewable energies (AUER)	2.67	1.32
My university takes action to promote energy efficiency (AUEE)	2.71	1.30
My university takes action to promote water efficiency (AUEH)	2.62	1.22
My university takes action to promote waste management (AUGR)	3.14	1.36
My university takes action to promote sustainable transport (AUTS)	2.32	1.30

environmental and social sustainability. These factors help students to leave university with a good knowledge of SD and behaviors that adhere to SD concepts. Additionally, the results indicated that the SD outside Class, via research activities, outreach programs, lectures and workshops, positively influences the students' awareness and increases their perception of the importance of SD. Another relevant factor is related to the SD Communication of the universities, which positively influences SD Knowledge.

The results in Table 7 verify the importance of HEIs in promoting SD. Of the dimensions that influence a student's life, involving family, friends, religion, relationships, government policy, media and many other factors, HEIs account for 27.7% (ModelSig. = 0.000) of a student's knowledge regarding SD concepts. The same scenario is observed on analyzing attitudes to sustainability, that is, proactivity regarding actions aimed at sustainability, with HEIs explaining 18.6% (ModelSig. = 0.000). Thus, HEIs play an important role in influencing the knowledge and behavior of students.

Construct analysis for each of the variables in Table 8 shows that

Table 7

Multiple linear regression results for strategies for the dissemination of SD concepts at HEIs and the level of knowledge/awareness and level of proactivity related to SD.

Independent Variables	Dependent variable SD Knowledge		Dependent variable SD Proactivity	
	B Coefficient	Sig.	B Coefficient	Sig.
(Constant)	1.839	0.000*	2.244	0.000*
SD in Class	0.288	0.000*	0.233	0.000*
SD outside Class	0.080	0.021*	0.029	0.415
SD Communication	0.118	0.000*	0.042	0.181
Infrastructure for SD	−0.122	0.000*	0.044	0.140
Control Variables				
Gender	−0.114	0.021*	−0.245	0.000*
Age Group	0.139	0.000*	0.111	0.002*
Graduation in environmental fields	0.507	0.000*	0.359	0.009*
Employment	0.103	0.036*	−0.022	0.659
Time at university	0.023	0.005*	0.006	0.449
Course level	−0.098	0.272	−0.072	0.422
Monthly Family Income	0.047	0.017*	−0.022	0.269
r ²	27.70		18.60	
ModelSig.	0.000*		0.000*	
VIF	From 1.043 to 2.586		From 1.043 to 2.586	
Durbin-Watson	1.877		1.900	
Pesarán-Pesarán	0.060		0.030	

23.10% of the students' SD Knowledge is explained by (ModelSig. = 0.000) SD in Class, 15.20% (ModelSig. = 0.000) by SD outside Class and 13.70% (ModelSig. = 0.000) by SD Communication. Also, all of the prompts of these three dimensions positively influenced SD Knowledge. The promotion of university activities, lectures and workshops on SD positively influences students' knowledge of/importance given to SD. Therefore, our results confirm the findings of Nejati and Nejati (2013), Wright and Wilton (2012), Katiliute and Daunoriene (2015), Lauder et al. (2015), Mafongosi et al. (2018) and Guerra et al. (2018). However, promoting quizzes/games negatively influences SD Knowledge, since students do not perceive a gain in knowledge related to SD through such

activities.

Our study confirms that SD activities in class raise the students' awareness about the importance of SD (DSSAE). These initiatives are strategic for disseminating concepts aimed at achieving a sustainable society, as they provide a chance to exchange experiences, develop projects, and evaluate results with the students. This finding is of use to teachers, highlighting the need to implement SD in the classroom. The existence of SD Communication, geared toward addressing students' doubts and questions on the subject, positively influences their SD Knowledge ($r^2 = 13.70$; ModelSig. = 0.000). However, communication initiatives must be accompanied by other practical initiatives. Among the green initiatives carried out on campus, students most noted the recycling initiative, as there is a strong campaign on the campuses for waste separation.

Communication enhances student participation in sustainable campus initiatives, confirming the findings of Disterheft et al. (2015), Perrault and Clark (2017), and Ribeiro et al. (2017). The results indicate that the Infrastructure for SD variables alone do not yield an increase in the SD Knowledge ($r^2 = 2.6$; ModelSig. = 0.000). Poor dissemination and engagement in SD initiatives have consequences, as seen from the results shown in Table 8, regarding Infrastructure for SD, representing 2.60% of students' perception of SD Knowledge. Some Infrastructure for SD prompts negatively influences the awareness/importance of SD perceived by the students.

In other words, the students do not observe investments directed toward the green initiative projects of the HEIs. The isolated development of GCIs does not produce results and must be aided by approaches that foster a holistic understanding of green initiatives on campus (Ribeiro et al., 2017). This result corroborates the findings in Table 6 that few classroom activities are related to the teaching of SD and GCI-related activities. Nevertheless, teaching can be enhanced by including GCIs in the teaching curricula of classes at HEIs (Ribeiro et al., 2018).

According to Lozano et al. (2013), for universities to become sustainability leaders and changemakers, they must ensure that the present and future generations are better trained so that university professionals effectively provide students with the tools to aid the transition toward

Table 8

Influence of the issues associated with strategies for the dissemination of SD concepts on the level of knowledge and awareness regarding SD (K-A-RG-SD).

Independent Variables	Dependent variables SD Knowledge			
	B Coefficient/Sig.	B Coefficient/Sig.	B Coefficient/Sig.	B Coefficient/Sig.
(Constant)	1.774*	2.593*	2.682*	3.176*
SD in Class				
UPDS	0.228*			
ASEAS	0.035			
PADS	0.149*			
UPADS	0.053*			
SD outside Class				
PPDS		0.107*		
PEDS		0.034		
PGDS		−0.059*		
PPADS		0.068*		
PWDS		0.125*		
SD Communication				
CUPDS			0.185*	
URDDS			0.092*	
Infrastructure for SD				
IUS				−0.029
AUER				0.045
AUEE				0.021
AUEH				0.047
AUGR				−0.014
AUTS				0.047*
r ²	23.10	15.20	13.70	2.60
Model Sig.	0.000*	0.000*	0.000*	0.000*
VIF	From 1.117 to 2.547	From 1.790 to 2.986	1.529	From 1.535 to 3.472
Durbin-Watson	1.821	1.751	1.695	1.689
Pesarán-Pesarán	0.058	0.041	0.032	0.029

Table 9

Influence of issues associated with SD dissemination on the level of SD Proactivity.

Independent Variables	Dependent variable SD Proactivity			
	B Coefficient/Sig.	B Coefficient/Sig.	B Coefficient/Sig.	B Coefficient/Sig.
(Constant)	2.110*	2.660*	2.719*	2.781*
SD in Class				
UPDS	0.148*			
ASEAS	0.051*			
PADS	0.117*			
UPADS	0.040			
SD outside Class				
PPDS		0.045		
PEDS		0.059*		
PGDS		0.075*		
PPADS		0.010		
PWDS		0.048		
SD Communication				
CUPDS			0.166*	
URDDS			0.051*	
Infrastructure for SD				
IUS				0.001
AUER				−0.006
AUEE				−0.031
AUEH				0.083*
AUGR				0.038
AUTS				0.131*
r ²	15.40	9.60	9.70	8.90
ModelSig.	0.000*	0.000*	0.000*	0.000*
VIF	From 1.117 to 2.547	From 1.790 to 2.986	1.529	From 1.535 to 3.472
Durbin-Watson	1.876	1.813	1.806	1.798
Pesarán-Pesarán	0.061	0.059	0.055	0.043

better sustainability standards (Alshuwaikhat and Abubakar, 2008). Guerra et al. (2018) highlighted that SD-driven curriculum design and GCIs are critical factors in fostering students' engagement and understanding of SD. When the HEI formulates and implements an SD plan for teaching, research and outreach, it positively affects the students' behavior (Dagiliūtė et al., 2018).

The dependent variable SD Proactivity, as shown in Table 9, is positive influenced (15.40%; *ModelSig.* = 0.000) by SD in Class, that is, of the proactivity associated with attitudes to sustainability of students, and 15.4% (*ModelSig.* = 0.000) is explained by learning in the classroom. However, the other initiatives, such as SD outside Class (9.60%; *ModelSig.* = 0.000), SD Communication (9.70%; *ModelSig.* = 0.000) and Infrastructure for SD (8.9%; *ModelSig.* = 0.000) present lower values, but still positively influence SD Proactivity.

The results obtained in this study are in line with the findings of Velazquez et al. (2006), Alshuwaikhat and Abubakar (2008), Suwartha and Sari (2013), Nejati and Nejati (2013), Lauder et al. (2015), Tan et al. (2014), Ribeiro et al. (2017), Perrault and Clark (2017), Fahrianto et al. (2018) and Mafongosi et al. (2018). It can be observed that becoming aware of SD Knowledge is different from having a proactive attitude towards it. Therefore, students understand SD but are still not widely encouraged by GCI programs to take actions aimed at achieving sustainability.

This effect is perhaps one of the biggest challenges in terms of promoting SD. It is not just a question of making students aware of a situation or promoting GCIs but using these dissemination programs to make people understand that they are also part of the change. It is not a case of waiting for the change to happen, but making the change happen. The students' behavior is a portrait of the broader society. Initiatives that place students as leaders of sustainability actions on campus are significant for understanding their role in promoting SD in society.

On analyzing the respondents' profiles, it was observed that the male gender has a lower SD Knowledge. Regarding age (men/women), the older respondents group had higher SD Knowledge. Employment and a higher monthly family income positively influence the awareness of/importance given to SD. Another significant finding is that employment,

time at university, and monthly family income positively influenced the level of knowledge and recognition of SD. The results indicate that male gender is negatively related to the propensity for carrying out initiatives associated with SD Proactivity. The oldest group is positively related to performing these initiatives and, finally, an individual who is graduating in the environmental area has the highest propensity to carry out such initiatives. At this time, we will not make inferences based on the student profiles, but the information reported herein could form the basis of future studies.

5.3. Lessons learned

Despite the growing number of studies on the subject and notable interest from universities in incorporating sustainability values into higher education, much remains to be done to ensure that HEIs remain on track to become "sustainable" and fulfill the goals of the sustainability agenda. This research attempts to identify this gap and propose a change in how sustainability policies for the HEIs are established. The following is a summary of the main findings obtained from the analysis of the students' perceptions, which suggest that:

- Students rarely seek information related to SD;
- Universities conduct few actions related to SD in the classroom;
- When the issues involve sustainability in the social sphere, initiatives and practices are carried out less;
- Higher education institutions have been ineffective in communicating SD propagation;
- Investment in green initiative projects at universities has not been observed by students who are not involved in research;
- The male gender is less prone to participate in initiatives related to SD practices;
- Older students consider themselves to have a greater understanding of SD;
- Research activities are the leading promoters of SD in universities;
- The SD dissemination strategies at HEIs represent 27.7% of the students' level of knowledge and awareness regarding SD;

- The extent to which SD is addressed positively influences the students' level of knowledge and awareness;
- Extracurricular activities related to SD positively influence the students' awareness of and importance given to SD;
- SD dissemination strategies explain 18.6% of students' level of proactivity regarding SD;
- The extent to which SD is addressed in class positively influences the level of proactivity regarding SD.
- Teachers' addressing SD issues and extracurricular activities related to SD positively influence the level of SD knowledge and awareness.
- Communication related to SD, to address students' doubts and questions on the subject, positively influence their level of knowledge and awareness.
- The SD dissemination strategies can increase the level of proactivity regarding SD.

In particular, this article explored students' views on SD dissemination strategies related to GCIs. Students are considered key stakeholders in SD and future leaders and thus they are arguably fundamental determiners of the success of SD. The establishment of GCIs is a strategy that involves infrastructure, education, outreach programs and research (Alshuwaikhat and Abubakar, 2008; Hooi et al., 2012; Suwartha and Sari, 2013; Ribeiro et al., 2017; Fahrianto et al., 2018), and that requires high investment in resources. Many of these resources are invested by society in universities in order to promote SD. This study indicates that these investments are essential and must be forthcoming, although the results show that this variable accounts for only 18.6% of the students' level of proactivity regarding SD. There is further potential for exploring in these initiatives, in the case of the institutions studied.

The results demonstrate that the students' understanding of SD is low and that there is a gap between valuing SD and putting SD practices into action. While researchers have been working on sustainability issues and methods for decades, the concept of sustainability itself may be wearing thin. The lack of understanding of the concept serves as an alert for sustainability scholars since, even among an educated population, the basic principles of sustainability can be misunderstood. Creating and implementing effective policies to combat environmental, social and economic problems, on the smaller scale of an HEI or the greater level of a nation, can be difficult when people do not understand key concepts of SD (Owens and Legere, 2015).

This lack of understanding varies but there is a recurring theme regarding the importance, establishment and actions of sustainable initiatives. One example is the strong association between sustainability and recycling perceived by students, demonstrating that massive campus-initiated policies to develop a recycling infrastructure have paid off. Students see the importance of reusing waste; hence they plan for it and carry it out. However, they should be more extensively involved in SD activities, even acting as creators and project managers for sustainability. University students in Canada, for instance, are already leaders in mitigating climate change, as reported by Helferty and Clarke (2009).

Research plays a strategic role in this intense student involvement with sustainability, and investment in research must be maintained (Jarchow et al., 2018). However, other areas of university infrastructure can be used, especially communication, which can be an effective form of engagement and information exchange (Ribeiro et al., 2020). One suggestion would be to develop a database in which all activities and data related to sustainability in the university, or the region in which they are located, are collected continuously and made accessible to all students and used in university research, outreach programs and teaching (Schoeps and Hemmer, 2018). With this tool, students could engage in SD initiatives more clearly, and adopt a bottom-up approach, reducing the gap between the aims of the HEIs administrators and what is understood and practiced by students.

This main recommendation to emerge from this study is to promote a greater approximation, involvement, and engagement of the students with the sustainability actions established at the university. HEIs should

focus their programs and policies on this type of organizational structuring. Indeed, signing international declarations of sustainability, committing to international policies and implementing community engagement projects will not be truly effective if universities ignore the basic principles of education aimed at sustainability, as defined in the Talloires Declaration. HEIs need to provide students with the ability to implement actions considering the principles of sustainability. Universities have the ability and commitment to achieve this goal, and systematically monitoring students' perceptions of GCIs is critical to promoting SD.

6. Conclusions

Multiple linear regression and influence analysis was used to measure the impact of GCIs at HEIs on students' SD awareness and proactivity. It was verified that SD dissemination strategies at universities help the students gain a better knowledge of and place greater importance on SD. This result indicates that the actions of universities can lead to graduates who have sufficient tools to develop SD practices and initiatives. However, with regard to the initiatives and practices carried out at the HEIs, such as the GCIs, the results suggest a negative relation with student SD knowledge and proactivity, an issue that needs to be addressed by the universities included in the study, since the establishment of initiatives alone does not guarantee enhanced SD awareness of the students.

These results of this study have important implications for university managers and decision-makers in higher education who seek to improve students' perception of SD. The findings reported herein, based on students' viewpoints, could aid the planning of HEIs in the transition to becoming a "sustainable university". A sustainable university can be defined as one that, in addition to seeking academic excellence, tries to incorporate human values into people's lives, in other words, a university that promotes and implements sustainability practices in teaching, research, community outreach, waste and energy management, land planning and land use through an ongoing commitment to monitoring and sustainability. Such an approach could improve the accountability of individuals and promote the expansion of sustainability practices within society.

In technical terms, this research has the limitation of the normality assumption in the central limit theorem, as well as the theoretical grouping of the variables studied, although the construct developed by the researchers displays internal consistency. Other limitations of this research are the lack of randomization of the prompts and the length of the questionnaire, which may have caused fatigue on the part of the respondents. One of the theoretical limitations is related to the fact that only the students' opinion is analyzed and not the managers' point of view. A possible bias in the interpretation of the SD actions carried out by the HEIs may lead to them being misunderstood by students, and this could be associated with 'communication noise'.

New studies need to be conducted to address these limitations. Future studies could focus on different regions of Brazil and other Latin American countries, including students and other campus users, to confirm the findings reported herein. Qualitative research that seeks to deepen student understanding is also essential. Quantitative research comparing several HEIs with different strategies of sustainability dissemination could provide results of interest to academia. The challenges encountered in this study were the difficulty in collecting data on students' perceptions and encouraging them to participate in the research. However, the theoretical contributions should aid in-depth studies in contexts other than those of HEIs. The results obtained are consistent with the findings of other studies performed in different countries and contexts, while the identification of the relations between the variables has not been previously reported in the literature. Thus, this article concludes with a quote from Owens and Legere (2015, p. 382): "what this means for policymakers, politicians, researchers, scholars, campus administrators, faculty and staff is clear: the work of

informing the next generation about sustainability is not over. In some cases, it may have just begun.”

CRediT authorship contribution statement

João Marcelo Pereira Ribeiro: Conceptualization, Investigation, Writing – review & editing, Supervision, Project administration, Funding acquisition. **Lenoir Hoeckesfeld:** Conceptualization, Methodology, Formal analysis, Validation, Investigation, Writing – review & editing, Writing – review & editing, Supervision, Project administration, Funding acquisition. **Cristian Baú Dal Magro:** Methodology, Formal analysis, Validation, Investigation, Writing – review & editing, Project administration. **Jacir Favretto:** Methodology, Formal analysis, Validation, Investigation, Writing – review & editing, Project administration. **Rodrigo Barichello:** Methodology, Formal analysis, Validation, Investigation, Writing – review & editing, Project administration. **Fernando Cesar Lenzi:** Methodology, Formal analysis, Validation, Investigation, Writing – review & editing, Project administration. **Leonardo Secchi:** Investigation, Writing – review & editing. **Carlos Rogério Montenegro de Lima:** Methodology, Formal analysis, Validation, Writing – review & editing. **José Baltazar Salgueirinho Osório de Andrade Guerra:** Conceptualization, Investigation, Writing – review & editing, Supervision, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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