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RESEARCH ARTICLE



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Implementing sustainability in teaching: The role of sustainability leadership and transformational leadership in the context of higher education institutions

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Abstract

This paper aims to explore the mechanism by which sustainability leadership (SL) and transformational leadership (TL) contribute to implementing sustainability-related aspects and the adoption of the SDGs by the teaching staff and whether these relationships are mediated by the higher education institutions' (HEIs) level of social innovation tendency. The authors relied on a world survey containing questions developed according to the literature to achieve the results, receiving 603 answers from teaching staff in 102 developed and developing countries. To analyse the data, exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were deployed to check the instruments and the model's structure of factors, and structural equation modelling with hypotheses testing was adopted to understand the level of significance and the magnitude of the relationship between the constructs. The results indicate that SL has a significantly strong relationship with TL, social innovation tendency, and the adoption of sustainability aspects in teaching; however, it is not possible to support the existence of a significant relationship between TL and the adoption of sustainability aspects in teaching, and between social innovation tendency and the adoption of sustainability aspects in teaching. Theoretical and practical implications are explored.

KEYWORDS

education for sustainable development, higher education institutions, social innovation, sustainability leadership, transformational leadership

1 | INTRODUCTION

Over the years, considerable research has been done on the role of higher education institutions (HEIs) in contributing to the sustainable development goals (SDGs) (United Nations, General Assembly, 2015). Among the several research strands, how

universities should assemble their internal systems (research, outreach, community engagement, campus operations, administration, teaching and learning) gained attention, since it can foster the universities' contribution towards the 2030 Agenda of Sustainable Development in several perspectives (Leal Filho, Shiel, et al., 2019; Sanches et al., 2021).

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One specific aspect that researchers are focusing on is how the SDGs could be implemented in teaching and learning practices (Caldana et al., 2021; Zamora-Polo & Sánchez-Martín, 2019). This aspect has become relevant, since it is related to one of the university's primary goals that require, for example, engagement from the management staff to support sustainability-related initiatives and teaching staff well-versed in sustainability issues to educate undergraduate and postgraduate students who will eventually hold important positions in enterprises, non-governmental organisations, research, government, etc. (Caldana et al., 2021; Rieg et al., 2021).

In this sense, one important approach suggested by the literature is that integrating the SDGs into teaching practices can increase students' involvement, preparing them to deal with sustainability challenges. Despite its importance, it may require greater systematic efforts from universities (Leal Filho, Skanavis, et al., 2019), whereby the whole HEI and its internal stakeholders are expected to interact and be mobilised (Vargas et al., 2019) to support the sustainability training of undergraduate and postgraduate students. This perspective implies that, in order to implement sustainability aspects into teaching, the HEIs need to undergo a change process (Rieg et al., 2021) towards becoming a more sustainability-oriented state, and, according to the change management theory, leadership is imperative in this process (Kotter, 2012).

Leaders can be defined as individuals capable of "influencing, motivating, and enabling others to contribute to the effectiveness and success of the organisations they are members of" (House et al., 2004, p.56). Though this might seem a simple definition at first glance, leadership is in fact considered a complex phenomenon; a researcher that aims to study this field might find just as many definitions as the number of authors publishing in the field (Van Seters & Field, 1990; Zhu et al., 2019). For example, van Seters and Field (1990) have identified 10 leadership eras, and each one contains several periods and embraces a number of theories and a myriad of concepts. In addition, depending on the leadership theory, at least three elements need to be addressed: leader, follower, and the context or environment where the dyad leader-follower functions (Oc, 2018; Uhl-Bien et al., 2014).

Considering, in turn, the efforts of HEIs in implementing sustainability, these three elements of leadership are evident. For example, the literature has covered the importance of management staff (e.g., programme coordinators, directors, deans, etc.) as sustainability leaders, exploring their traits, behaviours, knowledge, and other qualities they should have in order to successfully promote change towards sustainability (Leal Filho et al., 2020). Teaching staff can be considered leaders and followers at the same time, since they may be influenced by their superiors (e.g., programme coordinators, directors, etc.) and act as a leader when they interact with students and external stakeholders such as the civil society (followers), even though teaching staff have been considered only as leaders (Evans et al., 2013; Tian & Huber, 2019). In addition, students can be seen as sustainability followers in the classroom context, in which they might experience different sustainability teaching and learning approaches and practices chosen by teaching staff (Caldana et al., 2021), hoping

they will eventually become sustainability leaders in the future (Eustachio et al., 2023).

Finally, there are several internal and external contextual and environmental factors that could influence the dyad leader-follower, such as: (1) whether the university is a public or private HEI (Bautista-Puig & Sanz-Casado, 2021; Wang et al., 2020); (2) if the university is from a developed or developing country (Babu & Reddy, 2015; Kalliisa et al., 2019); (3) whether or not the university is geared towards social innovation; or even (4) if the university is part of a sustainability-oriented initiative, such as embracing the SDGs in its culture and strategies (Shiel et al., 2020; United Nations, General Assembly, 2015) or adopting the principles for responsible management education (PRME) in the case that the HEI is a business school (Haertle et al., 2017; UN PRME, 2022).

Despite the vibrant research done so far highlighting the importance of leadership in promoting change towards sustainable development in HEIs, this field is far from being saturated. For example, there is evidence in the literature that both sustainability leadership (SL) and transformational leadership (TL) are significantly relevant in implementing sustainability and employee sustainable performance or generating corporate sustainability performance (Burawat, 2019; Eustachio et al., 2023; Iqbal & Piwowar-Sulej, 2021; Jiang et al., 2017). Therefore, to achieve such goals, studying both aspects (SL and TL) in implementing sustainability is clearly an important path for researchers. When considering the importance of TL, for example, it is considered relevant because it allows the leaders to stimulate their followers' engagement in different spheres (such as sustainability), having direct effects on groups by creating a vision to guide the change. Therefore, TL could be considered a crucial concept for academics and practitioners, especially regarding the process of leading sustainable change towards more sustainability-oriented organisations (Çop et al., 2021; Eustachio et al., 2023).

Moreover, SL also requires attention, since it is proven to be vastly discussed as a crucial driver for sustainable practices, and its concepts have been evolving in the literature. It is considered an important factor for transformational change and a valuable differentiator when talking about leadership, since it allows a more holistic view of the context and a more empathic way to deal with a multi stakeholder environment, showing high potential for the field of study (Eustachio et al., 2023; Visser & Courtice, 2011). However, despite the vast research done so far on leadership as an agent of change for sustainable development in HEIs, there is still a gap in understanding which one of these leadership constructs significantly affects the level of social innovation at HEIs as well as the implementation of sustainability aspects in teaching by lecturers. Moreover, most of the studies that approach SL and TL try to understand their relation in companies (Burawat, 2019), while only a few studies tackle this issue in HEIs (Eustachio et al., 2023; Iqbal & Piwowar-Sulej, 2021).

This study aims to address these gaps by understanding deeply the role that SL and TL play in promoting changes in the HEIs' social innovation tendency and implementing sustainability aspects in the HEIs' teaching practices by the lecturers. To achieve the goals of this study, the authors created a questionnaire containing variables that

belong to instruments already validated in the literature and conducted a world survey with the teaching staff of HEIs.

The survey received 603 answers from teaching staff that belong to HEIs from 102 developed and developing countries. A theoretical model was developed to understand the relationship between the proposed constructs, and the PLS-SEM method was deployed to understand the significance level and the magnitude of the relationship between the constructs. Finally, the sample was divided into four to make it possible to understand the magnitude of the connections in four different scenarios: private universities, public universities, HEIs from developed countries, and HEIs from developing or transition countries.

1.1 | Theoretical background and hypotheses

Organisational change for sustainable development (Blanco-Portela et al., 2017) implies that leadership is one of the most crucial aspects of promoting change in the HEIs in several ways, such as motivating and influencing teaching staff so that they can contribute to the universities' sustainability practices by implementing sustainability into teaching and curricula (Collazo Expósito & Granados Sánchez, 2020; Leal Filho et al., 2020; Zamora-Polo & Sánchez-Martín, 2019).

The literature, in turn, presents two different leadership concepts, SL and TL, which are suggested to have a significant positive impact on organisations' many practices, which could lead to sustainability performance and innovative behaviour by employees in sustainable organisations (Blanco-Portela et al., 2017; Burawat, 2019; Iqbal & Piwowar-Sulej, 2021; Jiang et al., 2017; Leal Filho et al., 2020; Li et al., 2019; Manzoor et al., 2021). Moreover, according to the definition of Visser and Courtice (2011) about SL, TL is an important leadership style for leaders engaged with sustainability aspects. In this sense, considering the above-mentioned aspects, the literature suggests these are different constructs, but there is, however, a positive relationship between them:

H1. There is a positive covariance between SL and TL.

SL and TL are expected to contribute to sustainability performance. For example, Menon and Suresh (2021) suggest SL and institutional commitment as important enablers that could drive HEIs towards sustainability. Leal Filho et al. (2020), in turn, also have explored the aspects of SL through a world survey, indicating that if the management staff of universities have specific traits, behaviours, attitudes, and knowledge, it could lead HEIs towards sustainability performance. In the same line, Blanco-Portela et al. (2017) conducted an expert driven study with sustainability leaders from 45 HEIs in Latin American countries, identifying possible drivers and barriers that universities undergo in order to integrate sustainable practices. Moreover, TL has a positive effect on green work engagement (Çop et al., 2021), which could be extended to the context of teaching staff in implementing SD practices in teaching. These studies suggest that

SL and TL can foster the implementation of sustainability practices because of their activities, indicating that higher levels of SL and TL at HEIs are likely to motivate and influence teaching staff in implementing the SDGs in teaching.

H2. Higher levels of SL will be associated with higher levels of implementation of the SDGs in teaching.

H3. Higher levels of TL will be associated with higher levels of implementation of the SDGs in teaching.

Social innovation, in turn, refers to an instrument of social change where organisations adopt innovative practices or activities in order to contribute towards a social need. In this sense, social innovation can be considered as a new solution, a service, product, or process that aims to go further than the organisations' individuals' private benefits, where they engage in activities and goals that aim at meeting a social need and creating social value (Caulier-Grice et al., 2012; Pasricha & Rao, 2018; Phillips et al., 2015; Sanders et al., 2007). In this context, universities are expected to be open systems (Rasiah, 2019) that go beyond their routine goals and promote transformational change, fostering community engagement practices and promoting social impact (Bellandi et al., 2021; Morawska-Jancelewicz, 2022).

In this sense, if there is a social innovation tendency at HEIs aiming at meeting the needs of society, the teaching staff should also feel stimulated to innovate in their classes by implementing the SDGs into their teaching, revising the content of their classes to implement the SDGs, adopting community-related challenges as case studies in their classes, or encouraging students to engage in community projects related to social and environmental dimensions (see Collazo Expósito & Granados Sánchez, 2020; Eichler & Schwarz, 2019; Holmes et al., 2021). In other words, social innovation can foster educational practices related to the SDGs (Peng et al., 2022; Schröder & Krüger, 2019).

H4. Higher levels of social innovation tendency will be associated with higher levels of implementation of the SDGs in teaching.

Nonetheless, in order for an organisation to achieve a certain level of social innovation, some authors underline the importance of governance and leadership (Bellandi et al., 2021; Pasricha & Rao, 2018). This is well reported by Nabi and colleagues (2022) who suggest that TL has a positive impact on sustainability innovation and is considered a mediator between sustainable leadership and sustainable performance (Iqbal & Piwowar-Sulej, 2021). In this context, considering that leadership aspects positively influence social innovation tendency in companies and universities (Iqbal & Piwowar-Sulej, 2021; Pasricha et al., 2018), it is expected that both the SL and TL constructs will be associated with higher levels of social innovation tendency in HEIs.

H5. Higher levels of SL will be associated with higher levels of SI tendency in HEIs.

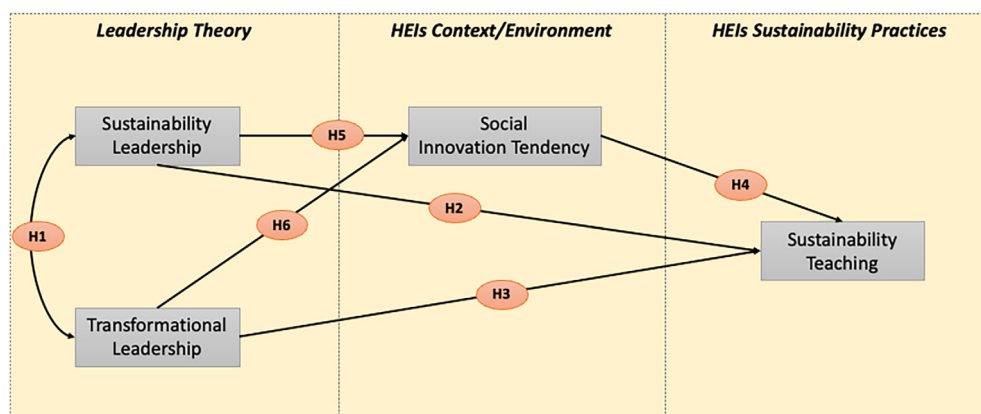


FIGURE 1 Theoretical framework.

H6. Higher levels of TL will be associated with higher levels of SI tendency in HEIs.

Taking the discussion provided in this section and the hypotheses built from the discussion in the literature, the authors have formulated the theoretical framework presented in Figure 1. This theoretical framework, as well as its independent variables and constructs' structure, will be further explored through the exploratory factor analysis (EFA), confirmatory factor analysis (CFA), and structural equation modelling (PLS-SEM) methods.

2 | METHODS

2.1 | Methodological background and sample description

This study was based on a world survey aimed at understanding the extent to which SL and TL impact the level of the HEIs' social innovation and sustainability teaching. The survey initially received 625 answers, where 22 entries were dropped due to the lack of quality of the data (e.g., participants who provided the same answer in all questions or incomplete answers), with the remaining 603 valid answers from teaching staff around the world from 102 different countries, of which 45% of the participants are from developed countries and 55% from developing or transition countries, considering the United Nations' current classification criteria (United Nations, 2022). Figure 2 presents the details of the respondents' countries as well as the frequency of respondents for each one. It is worth mentioning that this survey tried to address as many different countries as possible around the world in order to get a comprehensive overview of the topic. However, it was not possible to get the same number of answers from each country, due to several challenges such as access, language barriers, differing cultural attitudes towards participation in such studies, etc. Therefore, it implies that the data collected cannot be seen as a representative sample of those countries and cannot be generalised.

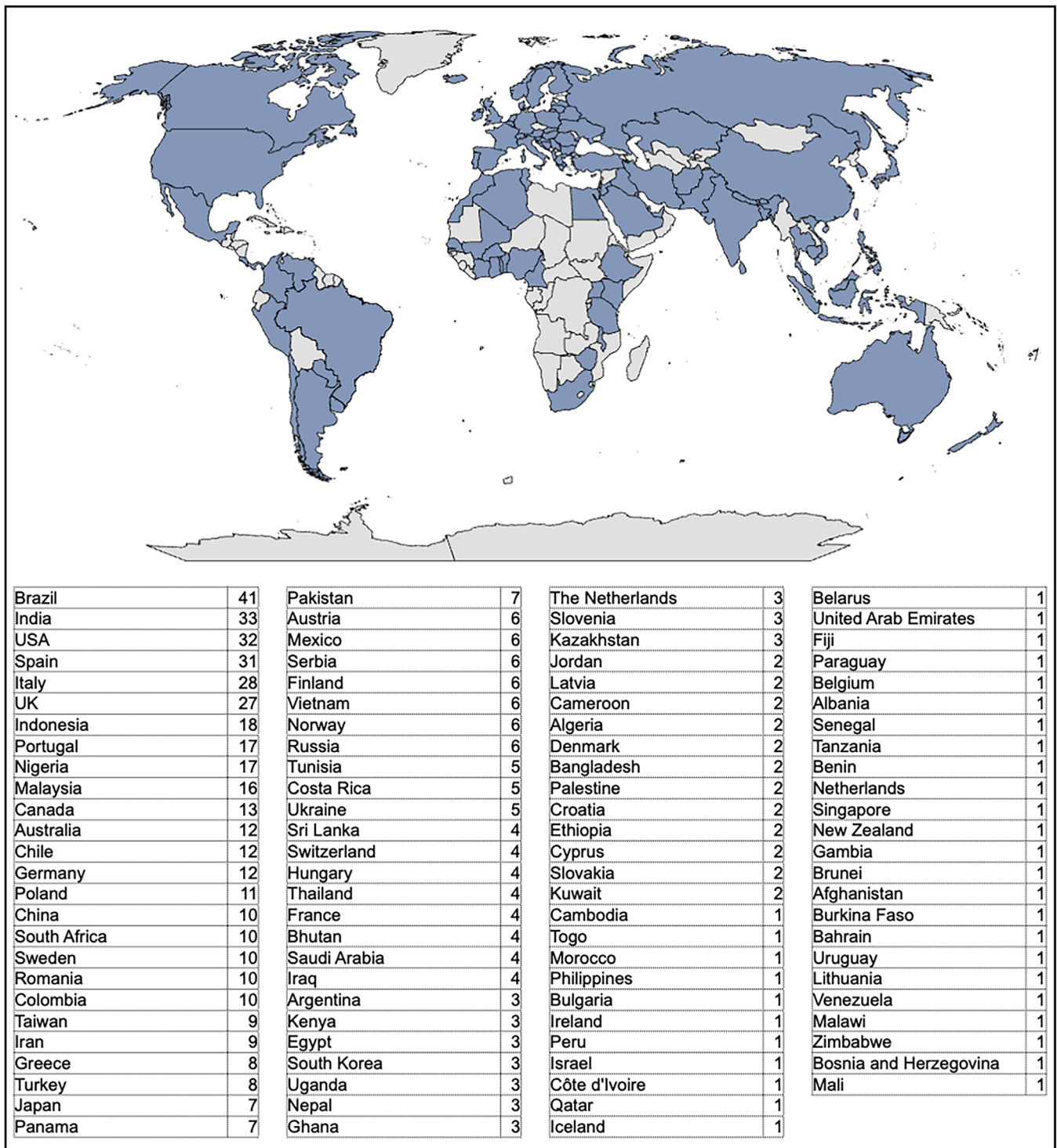
Table 1 details the sample of the 603 teaching staff from several fields who completed the survey. Among the sample, 35% reported

their age as less than 40 years, 30% reported to be between 40 and 49 years of age, and the remaining 35% were 50 years or older. Regarding gender, 57% reported as males, 42% as females, and 1% selected 'other or prefer not to say'. The majority of the respondents (97%) reported that they hold positions in teaching and research, while 3% were only engaged in teaching activities. Also, in terms of position, 60% of the respondents reported being undergraduate lecturers and 82% as master's or doctoral lecturers. In terms of the HEI classification, 18% of the respondents reported belonging to the teaching staff of private HEIs, while the majority of the sample (82%) are from public HEIs. Finally, when it comes to the size of the HEI in terms of number of students, 40% are teaching staff members of HEIs with up to 10,000 students, 34% of HEIs with between 20,000 students and 30,000 students, and 25% reported to be teaching staff of HEIs with more than 30,000 students.

All the 603 valid answers were considered to conduct further analysis according to the goals of this paper. The following subsection is designed to show the data collection deployed as well as to describe the instruments used in the survey, while section 3.3 presents the data analysis strategy where the authors explain the PLS-SEM methods.

2.2 | Data collection strategy and instrument description

To conduct the survey, a questionnaire (available upon request) was created in the English language with four main blocks of questions based on the literature. Before sending the questionnaire to the participants, the authors opted to send the questionnaire to four experts in the field of sustainable development education in the context of HEIs who provided helpful suggestions towards guaranteeing the questionnaire's content and face validity. In the second stage, the questionnaire was firstly developed in English and then sent for translation into Portuguese and Spanish by two researchers fluent in the field to allow greater participation from respondents from Brazil and other countries in South America. These versions were then translated back into the English language to check if the content was preserved in relation to the original questionnaire.



Notes: $n = 603$ respondents. 102 different countries.

FIGURE 2 Country distribution of responses. $n = 603$ respondents, 102 different countries.

In terms of the design of the questionnaire, it was built considering five blocks of questions. The first part aimed to gather the demographic information of the participants as well as collect information regarding their HEIs. The second section, in turn, was related to the teaching aspects and SDGs' implementation, and the third part embraced questions related to the construct SL in HEIs.

The fourth section covered TL in HEIs, and, finally, the fifth part considered questions related to social innovation. Table 2 summarises the variables of each construct (henceforth used as the code created) and shows a descriptive statistic of each question. It should be noted that the scales used for ST and SL differ from the ones used for TL and SI.

TABLE 1 Sample description.

Dimension	Item	Number	Percentage
Number of countries (Total = 102)	Developed countries	33	32%
	Developing or in transition countries	69	68%
Respondents (Total = 603)	Respondents from developed countries	271	45%
	Respondents from developing or in transition countries	332	55%
Age	18–29 years	24	4%
	30–39 years	185	31%
	40–49 years	183	30%
	50–59 years	136	23%
	More than 60 years	75	12%
Gender	Female	254	42%
	Male	345	57%
	Other/Prefer not to say	4	1%
Position (multiple choice)	Undergraduate Lecturer	361	60%
	Master's and/or Doctoral Lecturer	494	82%
Activity	Teaching	19	3%
	Teaching and research	584	97%
HEI classification	Private higher education institutions	108	18%
	Public higher education institutions	495	82%
HEI's number of students	Up to 5.000	127	21%
	Up to 10.000	114	19%
	Up to 20.000	123	20%
	Up to 30.000	86	14%
	More than 30.000	153	25%

Note: $n = 603$ respondents, 102 different countries.

The questions in each one of the four constructs mentioned before are based on the literature. The questions related to the implementation of SDGs in teaching were created in a five-point scale format, considering the most recent and cited literature in the field (Collazo Expósito & Granados Sánchez, 2020; DuPuis & Ball, 2013; Goodall & Moore, 2019; Leal Filho et al., 2021; Leal Filho, Shiel, et al., 2019; UN PRME, 2022). For the construct of SL, the authors used the questionnaire developed by Iqbal and Piwovar-Sulej (2021) for the context of HEIs, which was based on the Sustainable Leadership Questionnaire developed by McCann and Sweet (2014). The TL construct was adapted from the TL questionnaire first developed in the context of schools (Geijsel et al., 2009; Vermeulen et al., 2017). Finally, for the social innovation tendency construct, the authors used the questionnaire adapted by Iqbal and Piwovar-Sulej (2021) from Pasricha et al. (2018) in the context of universities. More specifically, the authors dropped the last question of that questionnaire, which states, 'I would like to be useful for the community without expectation of any financial benefit'; it did not make sense for this study because this survey encompasses answers from private and public HEIs, so this construct contained a set of 7 questions.

The data collection strategy adopted by the authors was an online world survey. Before the teaching staff started answering the questions related to the constructs previously discussed, the respondents needed to read the informed consent form. If they accepted to take

part in the survey, they would be automatically transferred to the following page to start answering the questionnaire. The survey was disseminated with the authors' networks and through the IUSDRP network (IUSDRP, 2022). The survey remained open from June 2022 to October 2022 and received 603 valid answers from teaching staff of HEIs from developed, developing, and transition countries, according to the United Nations' current classification criteria (United Nations, 2022).

Despite the high number of answers received, the authors are aware that this study adopted non-probability sampling, since sampling methods conducted online often reach small samples (Barratt et al., 2015). Moreover, the authors believe that there are several challenges involved in gathering answers, since teaching staff usually do not have time due to their busy schedules or simply are not willing to engage in online surveys.

Despite being aware of the non-probability sampling adopted in this study, the authors used the G*power (Heinrich Heine Universität Düsseldorf, 2024) to calculate the minimum number of answers required to perform the PLS-SEM method. In this sense, considering this model has four constructs, 48 questions, a chosen effect size of 0.3, and a significance power of 0.80, the minimum suggested sample required to proceed was 180 answers (p -value = .01). Therefore, considering this research achieved 603 respondents, the authors considered the sample sufficient to proceed with the PLS-SEM.

TABLE 2 Descriptive statistics.

Scale and sources	Codes	Description	Min	Max	Mean	SD
Sustainability teaching (TEACH) Developed based on: Collazo Expósito and Granados Sánchez (2020), DuPuis and Ball (2013), Goodall and Moore (2019), Leal Filho et al. (2021), Leal Filho, Shiel, et al. (2019), UN PRME (2022).	TEACH-1	Considering the approach used at your institution, how do you evaluate the support currently offered to academic staff to teach about Sustainable Development Goals (SDGs).	1	5	2.84	1.137
	TEACH-2	Please indicate to which extent you apply the SDGs—Sustainable Development Goals in your teaching.	1	5	3.39	1.035
	TEACH-3	I have voluntarily revised the content of my classes to add more issues connected to the SDGs.	1	5	3.74	1.142
	TEACH-4	My superior or the program coordinator asked me to add more issues connected to the SDGs in the content of my classes.	1	5	2.49	1.334
	TEACH-5	The curricula of the courses I teach at my university have been revised to include the SDGs.	1	5	2.98	1.337
	TEACH-6	Students usually ask for more teaching content related to the SDGs in the courses I teach.	1	5	2.52	1.183
	TEACH-7	The SDGs are part of my institution's educational plans and activities.	1	5	3.26	1.272
	TEACH-8	I use communities' sustainability-related challenges as case studies or examples in my classes.	1	5	3.70	1.214
	TEACH-9	I encourage my students to engage in community projects related to the social and/or environmental dimensions.	1	5	3.75	1.178
	TEACH-10	How do you evaluate your efforts regarding the process of teaching about the SDGs?	1	5	3.39	0.995
Sustainability leadership (SL) Adapted from: Iqbal and Piwovar-Sulej (2021), McCann and Sweet (2014)	SL-1	Your higher education institution leadership acts in a sustainable, socially responsible manner.	1	5	3.55	1.024
	SL-2	Your higher education institution leadership acts in a sustainable, environmentally responsible manner.	1	5	3.51	1.044
	SL-3	Your higher education institution leadership acts in a sustainable, ethically responsible manner.	1	5	3.56	1.040
	SL-4	Your higher education institution leadership's decisions are made while considering the entire organisation	1	5	3.39	1.092
	SL-5	Your higher education institution leadership's management officially recognises when a mistake is made that affects sustainability.	1	5	3.03	1.053
	SL-6	Your higher education institution leadership is willing to correct mistakes that affect sustainability.	1	5	3.31	1.039
	SL-7	Your higher education institution leadership attempts to use unique innovative methods.	1	5	3.40	1.099
	SL-8	Your higher education institution leadership puts the institution's purpose before its profit/or resource savings.	1	5	3.30	1.115
	SL-9	Your higher education institution leadership balances all responsibilities (economic, environmental, and social).	1	5	3.25	1.084
	SL-10	Your higher education institution leadership demonstrates sustainability by persevering through all types of change.	1	5	3.26	1.059
	SL-11	Your higher education institution leadership is concerned with how sustainability affects employees.	1	5	3.09	1.128
	SL-12	Your higher education institution leadership communicates sustainability decisions to all those involved.	1	5	3.15	1.166

(Continues)

TABLE 2 (Continued)

Scale and sources	Codes	Description	Min	Max	Mean	SD
Transformational leadership (TL) Adapted from: Geijsel et al. (2009), Vermeulen et al. (2017)	SL-13	Your higher education institution leadership attempts to build a culture of sustainability through its communication efforts	1	5	3.521	
	TL-1	The leadership of my higher education institution... [Uses all possible occasions to stipulate the vision of the higher education institution to the team, students, and others.]	1	7	4.63	1.610
	TL-2	The leadership of my higher education institution... [Refers explicitly to higher education institution goals during decision-making processes.]	1	7	4.69	1.623
	TL-3	The leadership of my higher education institution... [Clarifies for the team the relationship between the vision of higher education institutions and various initiatives taken from the board, partnerships, or national government.]	1	7	4.43	1.645
	TL-4	The leadership of my higher education institution... [Describes clearly, based on the higher education institution's vision the current problems.]	1	7	4.47	1.613
	TL-5	The leadership of my higher education institution..." [Outlines at meetings what the consequences are of the higher education institution' vision for the current ins and outs.]	1	7	4.37	1.627
	TL-6	The leadership of my higher education institution..." [Takes the views of individual lecturers seriously.]	1	7	4.29	1.647
	TL-7	The leadership of my higher education institution..." [Shows appreciation when a lecturer takes the initiative for improving education.]	1	7	4.64	1.655
	TL-8	The leadership of my higher education institution..." [Listens carefully to the ideas of team members.]	1	7	4.40	1.683
	TL-9	The leadership of my higher education institution..." [Helps teachers to express their emotions.]	1	7	3.91	1.747
	TL-10	The leadership of my higher education institution..." [Has an eye and ear for problems experienced by teachers when introducing innovations.]	1	7	4.14	1.656
	TL-11	The leadership of my higher education institution..." [Helps teachers to express and clarify their personal ideas about teaching.]	1	7	4.23	1.667
	TL-12	The leadership of my higher education institution..." [Encourages teachers to try out new things in line with their interests.]	1	7	4.52	1.694
	TL-13	The leadership of my higher education institution..." [Helps teachers to reflect on new experiences that they acquire as a teacher.]	1	7	4.36	1.713
	TL-14	The leadership of my higher education institution..." [Encourages teachers to think about how to improve our institution/department.]	1	7	4.58	1.697
	TL-15	The leadership of my higher education institution..." [Encourages the search for and discussing of new information and ideas relevant to the development of the institution/program.]	1	7	4.53	1.704
	TL-16	The leadership of my higher education institution..." [Involves individual teachers in an ongoing debate about their personal professional goals.]	1	7	4.15	1.725
TL-17	The leadership of my higher education institution..." [Encourages teachers to experiment with new teaching methods.]	1	7	4.68	1.684	

TABLE 2 (Continued)

Scale and sources	Codes	Description	Min	Max	Mean	SD
Social innovation (SI) Based on Iqbal and Piwowar-Sulej (2021), Pasricha and Rao (2018)	TL-18	The leadership of my higher education institution...” [Creates ample opportunities for teachers to develop professionally.]	1	7	4.52	
	SI-1	My higher education institution improves the quality of community life by offering social services.	1	5	3.51	1.056
	SI-2	My higher education institution looks for solutions to create political and social changes in society.	1	5	3.44	1.048
	SI-3	My higher education institution develops new training techniques to increase the innovative capacity of the community.	1	5	3.52	1.047
	SI-4	My higher education institution uses new technologies to solve problems and find solutions to social requirements.	1	5	3.57	1.034
	SI-5	My higher education institution looks for ways to increase social participation and cooperation in society.	1	5	3.57	1.033
	SI-6	My higher education institution employs novel ideas to generate social value and make society more effective.	1	5	3.45	1.054
	SI-7	My higher education institution looks for opportunities that will change social norms and rules.	1	5	3.36	1.077

Note: $n = 603$ participants.

2.3 | Data analysis strategy

This study is explanatory in its nature. To analyse the data, the authors adopted the variance-based structural equation modelling, also widely mentioned by the literature as partial least squares structural equation modelling (PLS-SEM). This method was considered adequate since it is suggested to be used when the researcher's goal is a prediction or theory development (Dash & Paul, 2021; Hair et al., 2017).

Before proceeding with the PLS-SEM, the authors followed the steps proposed by Hair et al. (2009) by firstly conducting the EFA, and then the CFA through the principal components method of extraction and varimax rotation technique (Henson & Roberts, 2006). In the second stage, the authors used the inspection of the variance inflation factor (VIF) to check the existence of multicollinearity (Menard, 2002; Vittinghoff et al., 2012) and computed the Cronbach's alpha to check the internal consistency of the measurement model (Hair et al., 2009). Finally, the authors checked if the model followed the Fornell and Larcker (Fornell & Larcker, 1981) standard for discriminant validity and verified to what extent the findings were susceptible to this issue using Herman's one-factor test (Podsakoff & Organ, 1986).

Before proceeding with the analysis, all the answers were exported into a single Microsoft Excel© spreadsheet. The raw data was analysed, and the entries without complete answers or good quality (e.g., respondents who answered the same alternative for all the answers) were excluded. In sequence, the IBM SPSS 26 (IBM SPSS Statistics 26, 2019) was used to run the EFA

and CFA, and the SmartPLS 4© software (SmartPLS, 2022) was deployed to perform the PLS-SEM analysis, as well as check the model's internal consistency, convergent validity, and discriminant validity.

3 | RESULTS AND DISCUSSION

3.1 | Validity and reliability analysis

To guarantee the quality of the survey instrument, the authors used scales validated in prior research (SL, TL and SI) and built the scale related to sustainability teaching while considering the most relevant literature in the field. Moreover, the authors also ran the pre-test with a Brazilian sample ($n = 36$) and further assessed the validity and reliability of the measures collected. In this study, we followed the two-stage approach suggested by Hair et al. (2009) of EFA followed by CFA. EFA was carried out with all survey measure items using the principal components method of extraction and varimax rotation technique (Henson & Roberts, 2006). Table 3 shows the final solution of EFA with four factors that explain 72.650% of the total variance (Hair et al., 2009).

Next, CFA was carried out to confirm the results of the EFA. Table 4 shows that all items in their corresponding construct have standardised loadings that are statistically significant ($p < .001$) and greater than 0.6. Inspection of the variance inflation factor (VIF) for multicollinearity showed that all of the variables presented values below the threshold of 10 (Menard, 2002; Vittinghoff et al., 2012).

TABLE 3 Exploratory factor analysis.

Items	Factors			
	1	2	3	4
TEACH-2	0.096	0.127	0.031	0.791
TEACH-3	0.11	0.068	0.012	0.801
TEACH-8	0.057	0.142	0.147	0.787
TEACH-9	0.016	0.141	0.189	0.672
TEACH-10	0.083	0.156	0.033	0.820
SL-1	0.302	0.749	0.258	0.147
SL-2	0.27	0.743	0.255	0.136
SL-3	0.32	0.739	0.203	0.151
SL-4	0.393	0.717	0.189	0.137
SL-5	0.325	0.741	0.219	0.115
SL-6	0.379	0.742	0.231	0.124
SL-7	0.315	0.638	0.315	0.125
SL-8	0.385	0.638	0.176	0.076
SL-9	0.368	0.738	0.241	0.154
SL-10	0.357	0.728	0.243	0.145
SL-11	0.376	0.697	0.258	0.126
SL-12	0.342	0.707	0.237	0.139
SL-13	0.324	0.732	0.221	0.125
TL-1	0.581	0.449	0.169	0.182
TL-2	0.616	0.411	0.166	0.148
TL-3	0.670	0.407	0.228	0.149
TL-4	0.677	0.415	0.222	0.092
TL-5	0.698	0.35	0.187	0.14
TL-6	0.751	0.413	0.188	0.079
TL-7	0.770	0.352	0.23	0.065
TL-8	0.759	0.394	0.273	0.044
TL-9	0.739	0.333	0.258	0.104
TL-10	0.787	0.347	0.236	0.054
TL-11	0.819	0.294	0.251	0.085
TL-12	0.827	0.26	0.289	0.066
TL-13	0.839	0.236	0.272	0.098
TL-14	0.807	0.285	0.296	0.055
TL-15	0.810	0.287	0.309	0.066
TL-16	0.769	0.269	0.25	0.066
TL-17	0.762	0.291	0.317	0.04
TL-18	0.756	0.264	0.335	0.016
SI-1	0.276	0.275	0.685	0.106
SI-2	0.374	0.308	0.716	0.146
SI-3	0.401	0.302	0.699	0.064
SI-4	0.356	0.281	0.739	0.09
SI-5	0.366	0.308	0.747	0.111
SI-6	0.371	0.297	0.762	0.122
SI-7	0.369	0.303	0.724	0.133
Eigenvalues	23.464	3.116	2.066	1.867
% of variance	29.758	21.335	13.278	8.280
% of cumulative variance	29.758	51.093	64.370	72.650

Note: Extraction method: Principal component analysis. Rotation method: Varimax with Kaiser Normalisation. Loadings with absolute value <0.500 were omitted. Kaiser-Meyer-Olkin measure of sampling adequacy = 0.977. Bartlett's test of sphericity, $p < 0.001$.

TABLE 4 Measurement model: loadings, composite reliability, and convergent validity.

Constructs/items	Loadings	Cronbach's alpha	Composite reliability	Average variance extracted
<i>Implementation of the SDGs in teaching</i>		0.853	0.858	0.535
TEACH-2	0.791			
TEACH-3	0.801			
TEACH-8	0.787			
TEACH-9	0.672			
TEACH-10	0.820			
<i>Sustainability leadership</i>		0.962	0.963	0.680
SL-1	0.749			
SL-2	0.743			
SL-3	0.739			
SL-4	0.717			
SL-5	0.741			
SL-6	0.742			
SL-7	0.638			
SL-8	0.638			
SL-9	0.738			
SL-10	0.728			
SL-11	0.697			
SL-12	0.707			
SL-13	0.732			
<i>Transformational leadership</i>		0.979	0.980	0.727
TL-1	0.581			
TL-2	0.616			
TL-3	0.670			
TL-4	0.677			
TL-5	0.698			
TL-6	0.751			
TL-7	0.770			
TL-8	0.759			
TL-9	0.739			
TL-10	0.787			
TL-11	0.819			
TL-12	0.827			
TL-13	0.839			
TL-14	0.807			
TL-15	0.810			
TL-16	0.769			
TL-17	0.762			
TL-18	0.756			
<i>Social innovation</i>		0.947	0.948	0.719
SI-1	0.685			
SI-2	0.716			
SI-3	0.699			
SI-4	0.739			
SI-5	0.747			
SI-6	0.762			
SI-7	0.724			

TABLE 5 Measurement model: intercorrelations and discriminant validity.

Construct	Mean	SD	TEACH	SL	TL	SI
TEACH	3.594	0.882	0.732			
SL	3.316	0.906	0.397	0.825		
TL	4.419	1.442	0.292	0.805	0.853	
SI	3.488	0.914	0.335	0.742	0.773	0.848

Note: Fornell-Larcker criterion: diagonal elements in bold represent the square root of AVE, non-diagonal elements (non-bold) are the correlation among constructs.

Therefore, considering that multicollinearity is a minor problem with a large sample size (Jongh et al., 2015) and the inspected VIF values, we did not foresee any problems with multicollinearity in our model.

Table 5 also shows that Cronbach's alpha and composite reliability exceeded the recommended threshold of 0.70, which demonstrates the internal consistency of the measurement model (Hair et al., 2009). The average variance extracted from the measures ranges between 0.535 and 0.727. Therefore, they are higher than 0.50 and meet the current criterion for convergent validity (Hair et al., 2009). Table 5 shows that the model follows Fornell and Larcker's (Fornell & Larcker, 1981) standard for discriminant validity: the square root of the AVE for each construct (diagonal elements) needs to be significantly higher than the correlation matrix of the constructs (off-diagonal values in rows and columns). Accordingly, the measurement model had the necessary properties to proceed to PLS-SEM: internal consistency, convergent validity, and discriminant validity.

Finally, because we collected independent and dependent constructs using a single instrument, we adopted several procedures to minimise the common method bias threat to the validity of the results. In particular, (1) the questionnaire design considered a specific section for each construct; (2) the research participation was anonymous; and (3), the participants were informed that questions did not have a right or wrong answer. Additionally, we verified to what extent our findings are susceptible to this issue using Herman's one-factor test (Podsakoff & Organ, 1986).

There is a data problem when a single factor is responsible for a large proportion of the variation in the resulting factors from EFA. In our case, there is no extraction of a single factor in the EFA, considering the criterion of an eigenvalue greater than 1.00, and nor is a unique factor responsible for the majority of the covariance among the constructs. Our EFA with all items indicates that the largest factor explains only 29.758% of the total variance, so the common method bias will likely not threaten our results.

3.2 | Hypothesis testing

The structural model allows for verification of how well the empirical data support the theoretical model given by our set of hypotheses.

Table 6 reports the results in three stages: baseline model, mediating effects, and full model. We will focus on the last one.

The structural model (Figure 3) reveals that SL is positively and significantly related to TL ($\beta = .805, p < .0001$), which lends strong support for H1. Also, SL has a significant and positive effect on SI ($\beta = .339, p < .0001$) and in TEACH ($\beta = .410, p < .0001$), supporting H2 and H5. The PLS-SEM also demonstrated that TL has a significant and positive effect on SI ($\beta = .502, p < .0001$) supporting H6; however, it is not possible to say that it has a significant effect on TEACH ($\beta = -.156, p > .05$), leading to not supporting H3. Finally, the results show that SI does not have a significant effect on TEACH ($\beta = .152, p > .05$), rejecting H4. These results evidence that both SL and TL are important to developing SI at HEIs (Iqbal & Piwovar-Sulej, 2021; Pasricha et al., 2018); however, there is no evidence that TL could contribute to the implementation of sustainability aspects and SDGs adoption into the HEIs' teaching in a direct or indirect way (through SI).

In addition, this result also suggests that SL is a construct that is more effective in terms of influencing the teaching staff towards the implementation of sustainability practices in the HEIs' educational systems (Leal Filho et al., 2020; Menon & Suresh, 2021), and a combination of both styles indicated that HEIs could achieve higher levels of SI (Bellandi et al., 2021) and succeed in the implementation of sustainability practices.

In addition, since leadership is a phenomenon that involves not only the dyad leader-follower but also the context which can further influence the dyad, we tested whether the results could change when the analyses are conducted using four different sub-samples: (1) teaching staff from developed countries; (2) teaching staff from developing and transition countries; (3) teaching staff from private HEIs; and (4) teaching staff from public HEIs. As expected, the hypotheses remained the same; however, we noticed that the magnitude changed when compared to the models conducted for specific sub-samples. For example, the magnitude of the influence of SL \rightarrow TEACH and SL \rightarrow SI was higher in developed countries, but the relationship between SL \rightarrow SI was lower in developed countries. Also, when comparing private HEIs with public HEIs, of SL \rightarrow TEACH and SL \rightarrow SI were higher in private HEIs, but the relationship SL \rightarrow SI was lower in private HEIs.

3.3 | Discussion

The hypothesis testing evidenced that both SL and TL are important to developing SI (Iqbal & Piwovar-Sulej, 2021; Pasricha et al., 2018) at HEIs. As also observed by Iqbal and Piwovar-Sulej (2021), high SL is needed for optimal SI. Skills associated with TL and SL are therefore reinforced by the findings to support SI. On the other hand, even though the literature confirms the role of leadership in maximising sustainability efforts at HEIs (Blanco-Portela et al., 2017; Leal Filho et al., 2020) this study provided no evidence that TL could contribute to the implementation of sustainability aspects and the adoption of SDGs into the HEIs teaching in a direct or indirect way (through SI).

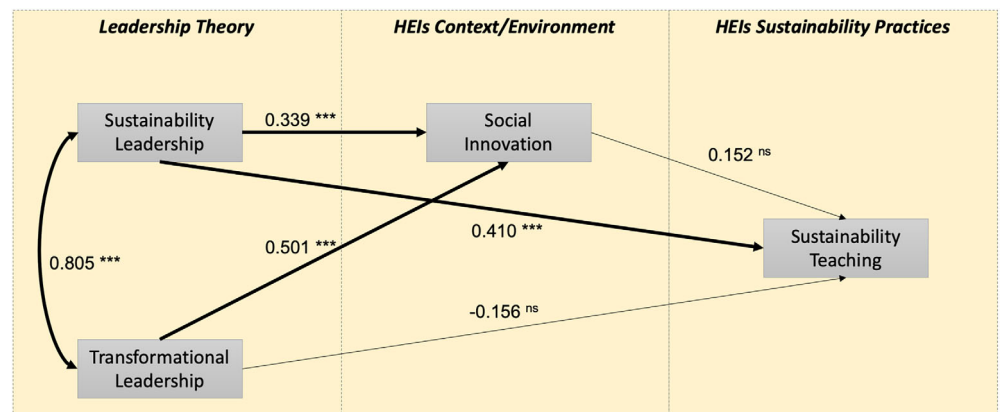
In addition, this result also suggests that SL is a construct that is more effective in terms of influencing the teaching staff towards the

TABLE 6 Structural model main results.

Relationships	Model 1 (baseline)	Model 2 (mediation effect)	Model 3 (full model)	Hypothesis test
Cov. (SL, TL)	0.805*** (0.000)	0.805** (0.000)	0.805*** (0.000)	(H1) Supported
SL → TEACH	0.459*** (0.000)		0.410*** (0.000)	(H2) Supported
TL → TEACH	−0.077 ^{ns} (0.339)		−0.156 ^{ns} (0.093)	(H3) Not supported
SL → SI		0.339*** (0.000)	0.339*** (0.000)	(H5) Supported
TL → SI		0.500*** (0.000)	0.501*** (0.000)	(H6) Supported
SI → TEACH		0.337*** (0.000)	0.152 ^{ns} (0.070)	(H4) Not supported
	R ² TEACH 0.0157	R ² SI = 0.639 R ² Teach = 0.112	R ² SI = 0.639 R ² Teach = 0.168	

Note: *** <0.001; Fit summary: SRMR (0.041); d_ULS (1.546); d_G (1.294); Chi-square (4467.453); NFI (0.846).

Abbreviation: ns, not significant.

FIGURE 3 Structural model results.*** <0.001; ns, not significant.

Notes: *** < 0.001; ns = not significant

implementation of sustainability practices in the HEIs' educational systems (Leal Filho et al., 2020; Menon & Suresh, 2021). According to Leal Filho et al. (2020), good leadership is strongly associated with curriculum change and investments in education for sustainability. In fact, these actions seem to be more promoted by SL than those of sustainability projects, procurement, and reporting.

A combination of both styles—SL and TL—indicated that HEIs could achieve higher levels of SI and succeed in the implementation of sustainability practices. Additionally, sustainability would not only be further implemented in the educational sector but also maximised by innovation in other sectors, such as government, civil society, and businesses (Bellandi et al., 2021).

The testing results regarding the sub-samples (Table 7 and Table 8) evidenced that contextual factors (developed country and private HEIs) might act as important moderators, raising the influence that SL has in teaching practices and SI tendency (Babu & Reddy, 2015; Bautista-Puig & Sanz-Casado, 2021; Kaliisa et al., 2019; Wang et al., 2020), requiring further exploration.

3.4 | Limitations

This study has some limitations. The study focuses on the influence of SL and TL on social innovation and sustainability teaching. Other

potentially relevant factors or variables that could impact these outcomes may not have been considered. In terms of the sample, it is important to mention that the survey did not obtain an equal number of responses from each country, leading to an uneven distribution of participants. The language and cultural barriers could have influenced participation rates, as well as the interpretation and understanding of the survey questions. These aspects may limit the generalisation of the results in different cultural contexts, as well as its generalisation to the entire population of teachers or HEIs globally.

4 | CONCLUSIONS

This study aimed to explore the mechanism by which SL and TL contribute to implementing sustainability-related aspects and the adoption of SDGs by the teaching staff and whether these relationships are mediated by the HEIs level of SI tendency. In this sense, a world survey was conducted to gather the opinions of teaching staff, receiving 603 complete answers from teaching staff from 102 countries. The theoretical model presented internal consistency, convergent validity, and discriminant validity, allowing us to proceed with PLS-SEM. In general, the results indicate that SL has a significant and strong relationship with TL, social innovation tendency, and the adoption of sustainability aspects in teaching; however, it is not possible to support the existence of a significant relationship between

TABLE 7 Structural model results—developed and developing or transition countries.

Relationships	Developed countries			Developing or transition countries			Hypothesis test
	Model 1 (baseline)	Model 2 (mediation effect)	Model 3 (full model)	Model 1 (baseline)	Model 2 (mediation effect)	Model 3 (full model)	
Cov. (SL, TL)	0.815*** (0.000)	0.815*** (0.000)	0.815*** (0.000)	0.800*** (0.000)	0.800*** (0.000)	0.800*** (0.000)	Supported
SL → TEACH	0.511*** (0.000)	0.468*** (0.000)	0.468*** (0.000)	0.462*** (0.000)	0.462*** (0.000)	0.411*** (0.000)	Supported
TL → TEACH	-0.193 ^{ns} (0.115)	0.378*** (0.000)	-0.255 ^{ns} (0.087)	-0.014 ^{ns} (0.902)	0.320*** (0.000)	-0.099 ^{ns} (0.429)	Not supported
SL → SI		0.466*** (0.000)	0.378*** (0.000)		0.516*** (0.000)	0.321*** (0.000)	Supported
TL → SI		0.285*** (0.000)	0.466*** (0.000)		0.388*** (0.000)	0.515*** (0.000)	Supported
SI → TEACH	R ² TEACH = 0.130	R ² TEACH = 0.078 R ² SI = 0.645	R ² TEACH = 0.134 R ² SI = 0.648	R ² TEACH = 0.199	R ² TEACH = 0.148 R ² SI = 0.630	R ² TEACH = 0.206 R ² SI = 0.630	Not supported

Note: *** <0.001; ** <0.01; * <0.05.

Abbreviation: ns, not significant.

TABLE 8 Structural model results—Private and public HEIs.

Relationships	Private HEIs			Public HEIs			Hypothesis test
	Model 1 (baseline)	Model 2 (mediation effect)	Model 3 (full model)	Model 1 (baseline)	Model 2 (mediation effect)	Model 3 (full model)	
Cov. (SL, TL)	0.847*** (0.000)	0.847*** (0.000)	0.847*** (0.000)	0.792*** (0.000)	0.792*** (0.000)	0.792*** (0.000)	Supported
SL → TEACH	0.654** (0.001)	0.654** (0.001)	0.585* (0.011)	0.423*** (0.000)	0.423*** (0.000)	0.379*** (0.000)	Supported
TL → TEACH	-0.116 ^{ns} (0.659)	0.427*** (0.004)	-0.186 ^{ns} (0.467)	-0.078 ^{ns} (0.390)	0.321*** (0.000)	-0.155 ^{ns} (0.136)	Not supported
SL → SI		0.471*** (0.000)	0.427*** (0.004)		0.503*** (0.000)	0.321*** (0.000)	Supported
TL → SI		0.496*** (0.000)	0.471*** (0.000)		0.302*** (0.000)	0.503*** (0.000)	Supported
SI → TEACH	R ² TEACH = 0.300	R ² TEACH = 0.239 R ² SI = 0.740	R ² TEACH = 0.301 R ² SI = 0.741	R ² TEACH = 0.129	R ² TEACH = 0.089 R ² SI = 0.610	R ² TEACH = 0.136 R ² SI = 0.610	Not supported

Note: *** <0.001; ** <0.01; * <0.05.

Abbreviation: ns, not significant.

TL and the adoption of sustainability aspects in teaching in a direct and indirect way through social innovation tendency.

The implications of this study are threefold. Firstly, it delivers a theoretical model to the research community, evidencing the importance of SL and TL in contributing to the HEI's social innovation tendency. Secondly, since SL was able to significantly influence the implementation of sustainability practices and the adoption of the SDGs by the teaching staff, it suggests that HEIs need to invest in SL training programmes for the administrative staff. Thirdly, the authors believe that the results make room for some reflections on the importance of the HEIs' internal and external context, suggesting that the magnitude of the effect of SL on SL and sustainability teaching would increase if the HEI is from a developed country, is a private institution, or is part of a sustainability-oriented initiative such as embracing the SDGs in its culture and strategies.

AUTHOR CONTRIBUTIONS

This work represents a collaborative effort by all authors. Below, we detail the contributions made by each member of the team: **Conceptualization:** João Henrique Paulino Pires Eustachio; Walter Leal Filho; Adriana Cristina Ferreira Caldana. **Methodology:** João Henrique Paulino Pires Eustachio; Amanda Lange Salvia; Yana Medeiros Guimarães; Laís Viera Trevisan; Jelena Barbir; Luciana L. Brandli. **Writing—Original draft preparation:** João Henrique Paulino Pires Eustachio; Walter Leal Filho; Amanda Lange Salvia; Yana Medeiros Guimarães; Luciana L. Brandli; Laís Viera Trevisan; Jelena Barbir; Adriana Cristina Ferreira Caldana. **Writing—Review and editing:** João Henrique Paulino Pires Eustachio; Walter Leal Filho; Adriana Cristina Ferreira Caldana.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

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