Sustainable development in Portuguese higher education institutions from the faculty perspective

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ABSTRACT

Higher education institutions play a fundamental role and have great responsibility in promoting sustainability and achieving sustainable development goals. It is therefore essential to study the teacher's perceptions of incorporating sustainability since they are responsible for promoting competences and preparing citizens to respond with solutions to future challenges. The aim of this research is to analyse the perceptions of sustainability held by teachers at Portuguese public higher education institutions. A descriptive and exploratory study was conducted by administering an online questionnaire. The sample is made up of 444 teachers from different Portuguese public higher education institutions (54.1% women and 45.9% men). The results show that while most teachers believe higher education institutions promote the integration of sustainability in their activities, only 16% consider that sustainable development is holistically integrated in the institutions' different activities. About 30% of the teachers report that they largely or extensively integrate sustainable development in their curricular units, but only 20% of them state that higher education institutions provide regular or systematic training in SD. Teachers prefer to increase students' sustainable development education through conferences, seminars, or research projects. Almost 90% of teachers are concerned about climate change or the environment, but only 40% or less engage in sustainable development-related activities. Four clusters are also identified, representing teachers' different perceptions of the higher education institutions' promotion of sustainability, teachers' participation in sustainable development issues and concerns about climate change. Although teachers feel that sustainability is starting to be integrated in higher education institutions, this is not done holistically; moreover, differences are found between teachers in polytechnics and universities and between different scientific areas.

1. Introduction

The role played by the internal stakeholders of Higher Education Institutions (HEIs) in fostering sustainability has been increasingly highlighted in recent times, and the training of their stakeholders has been identified as one of the key drivers of sustainability actions (Sánchez-Carrillo et al., 2021). While top management is undoubtedly essential in this process, it is necessary to develop skills that allow teachers to integrate sustainability in all aspects of the education system (Kiesnere and Baumgartner, 2020). It is therefore vital to understand the teachers' perceptions of sustainability and the sustainable development goals (SDGs) in HEIs, and in particular its role in teaching, research and integration on campus, as well as its importance for the institution's

development and the teachers' responsibility in this pursuit as educators. Integrating sustainability in higher education remains problematic (Veidemane, 2022), so insights into teachers' perceptions will help adjust strategies so that they favour the holistic integration of sustainability in HEIs, communicate this integration to all stakeholders effectively, and identify the barriers and challenges to be overcome. This work strives to fill gaps identified in previous studies (Aleixo et al., 2021; Ferguson et al., 2021; Georgiou et al., 2021; Saqib et al., 2020).

Several studies note the importance of the different HEIs stakeholders in fostering sustainability, namely top management, teachers and students (Aleixo et al., 2018bb; Cebrián et al., 2019; Dagiliūtė et al., 2018; Ferrero-Ferrero et al., 2018; García-González et al., 2020; Radzi et al., 2022; Ribeiro et al., 2021; Saqib et al., 2020). However, few works

examine the teachers' perspective of HEIs' commitment to sustainability and the SDGs and its holistic incorporation throughout the system, their understanding of teaching sustainability and SDGs, their perceptions of climate change or their participation in activities to promote sustainability. A holistic approach to sustainability is needed, integrating all dimensions (environmental, social, economic and human) into the curriculum to create a sustainable and prosperous society and quality of life for this and future generations. Schools and higher education, in particular, can set an example and replicate good practices that can be scaled up globally to achieve fairness and equity in access to quality education for sustainable development. There is limited research about the perceptions and attitudes to sustainability and SDGs of HEI teachers (e.g., Georgiou et al., 2021; Lazzarini et al., 2018). This study aims to contribute to reducing this gap.

The aim of this research is to analyse the perceptions of sustainability held by teachers at Portuguese public higher education institutions. The application of the study to higher education teachers in Portugal has several relevant reasons. Firstly, some studies show that Portuguese higher education students have a low level of knowledge about sustainability and the SDGs (e.g., Ferreira et al., 2023); therefore, it is of interest to understand teachers' perceptions of the extent to which they have integrated the topics in their teaching-learning processes. Secondly, in Portugal, the majority of HEIs still do not consider sustainability in an integrated way within the scope of their educational activities and curricula (Duarte et al., 2023; Farinha et al., 2020), so it is relevant to ask teachers about the extent to which they integrate SD in their curricular units and training activities. Thirdly, although in Portugal there are no national policies or government guidelines for integrating Education for Sustainable Development (ESD) into higher education, there have been initiatives by networks of teachers, researchers and staff to promote cooperation between HEIs and to implement sustainability principles and practices (Duarte et al., 2023) - such as the Sustainable Campus Network[1] and ORSIES Observatory of Social Responsibility and Higher Education Institutions[2] - which justifies a deeper understanding of how these issues are being integrated in HEIs, according to the perceptions of their teachers.

2. Faculty perceptions, motivations and challenges related to sustainability and education for sustainability

Despite recognition of the importance of sustainability, there is still a great lack of knowledge about the concept, its dimensions, activities, implementation, incorporation, and the new methodologies available to teach for SD. For Radzi et al. (2022), the perceptions and awareness of the topic determine the successful implementation of sustainability efforts.

Although some international studies have attempted to shed light on teachers' perceptions of sustainability (e.g., Cotton et al., 2009), they have failed to identify the barriers and challenges that hinder its incorporation in education and the commitment of all stakeholders, notably teachers to this task. According to Ferguson et al. (2021), teachers are critical agents in delivering SD content and facilitating skills and action competence for this purpose. Sammalisto et al. (2014) conducted a literature review on the teachers' perceptions highlighting their importance in the implementation of ESD; these authors defend that faculty perceptions of sustainability in teaching are divided into three categories: concept, resources and justice.

Still in this context, and in order to understand the challenges of incorporating SD in the curriculum, it is important to recognize the distinction between education about sustainability and education for sustainability (Shephard and Furnari, 2013). Cheng et al. (2022) noted the development of the concept of ESD along two lines: (i) integration of

SD into education systems; and (ii) how education has been embedded in the discourse of SD.

The main challenge for the integration of sustainability in HEIs, namely in the curriculum, is that SD and SDG topics are not directly related to all subjects. For example, whereas marine biotechnology or energy and environmental engineering courses will in themselves involve sustainability concepts, this is not the case of most courses (e.g., disciplines related to exact sciences). The Aleixo et al. (2021) study on the perceptions of students from different scientific areas concludes that the scientific background of the student influences the results, namely students from natural and environmental sciences have the strongest perception of SD and those in the exact sciences and engineering the weakest. According to Shephard and Furnari (2013), education for sustainability refers to the development of knowledge, skills, principles and arguments to achieve sustainability but that education about sustainability refers to concepts related to sustainability and SDGs. On the other hand, Cotton et al. (2009) reveal some of the limitations of incorporating SD into the curriculum: (i) limited relevance of SD to some disciplines; (ii) tensions between top-down and bottom-up approaches, and (iii) conflict with traditional higher education pedagogies. Authors have drawn attention to several factors that highlight the difficulty of integrating sustainability into higher education, notably in education (Busquets et al., 2021; Cotton et al., 2009; McMillin and Dyball, 2009; Verhulst and Lambrechts, 2015). Busquets et al. (2021) show that the environmental dimension predominates over other dimensions. As for the incorporation of sustainability in the curriculum, teachers refer to barriers such as being considered an irrelevant subject, lack of time and the costs involved (Cotton et al., 2009). Verhulst and Lambrechts (2015) also refer to the following barriers: (i) the lack of awareness or interest in SD issues; (ii) the bureaucratic structure of higher education; and (iii) the lack of resources and support. For McMillin and Dyball (2009), education for sustainability is confined to certain courses, it is often isolated from research and is not linked to sustainable campus operations. Given the various barriers, HEIs must overcome a range of challenges to attain institutional commitment, especially through training their faculty for sustainability, namely: emphasizing all dimensions of sustainability, promoting a holistic concept of sustainability, and fostering new pedagogical strategies for teaching sustainability (Busquets et al., 2021). Cotton et al. (2009) make some suggestions about how to incorporate SD into the higher education curriculum, namely: (i) its informal inclusion in the curriculum; (ii) making small changes whenever possible; (iii) good practices in areas such as paper or energy management.

With regard to teaching sustainability, studies refer to practical student-centered pedagogical strategies, such as service learning, project-based learning and challenge-based learning (Busquets et al., 2021). Vega-Marcote et al. (2015) advocate the experimental teaching model, which proposes selecting socio-environmental actions that involve improving the sustainability of the faculty and the campus.

For Lazzarini et al. (2018), faculty involvement in SD results from a concerted strategy of policies and mechanisms that facilitate the integration of policies into higher education, namely through the recognition of the work of academics engaged in SD.

To better understand faculty perceptions of sustainability pedagogy, it is necessary to distinguish between top-down and bottom up approaches. According to Tziganuk and Gliedt (2017) the top-down approach includes creating missions, programs, and courses based solely on sustainability concepts, theory, or practice; on other hand, the bottom-up approach focuses on integrating sustainability concepts, theory, or practice into existing degrees and coursework in established disciplines.

Alkhayyal et al. (2019) and McMillin and Dyball (2009) note that numerous HEIs have adopted the top-down sustainability approach, where the senior management took the initiative to create sustainable HEIs through education, research, and campus operations (Alkhayyal et al., 2019; McMillin and Dyball, 2009). Sammalisto et al. (2014) underline the need for action to come from top management in order to

[1] http://www.redecampussustentavel.pt/.
[2] https://orsies.forum.pt/.

inspire all stakeholders.

The literature review shows that despite an initial interest in analyzing teachers' perceptions of SD, it seems superficial and very few studies scrutinize teachers' opinions within the scope of their educational action in greater depth. Hence the need for this analysis to determine whether teachers consider ESD to be a relevant way of developing attitudes in young people and future leaders. Moreover, existing studies have focused primarily on secondary education (Ferguson et al., 2021; Hobusch and Froehlich, 2021), the challenges of online learning (Eloff et al., 2022; Shah et al., 2022) or on analyzing the perceptions of future teachers and those not currently teaching (García-González et al., 2020). Although much research has been conducted on the importance of developing the competences for SD of future teachers; studies on current higher education teachers are scarce.

3. Methods

3.1. Data collection and sample

Teachers' perceptions were analyzed using an on-line questionnaire administered to teachers at Portuguese public HEIs, namely polytechnics and universities. It is a descriptive and exploratory study supported by a quantitative reporting of the findings. The questionnaire was administered online, through an institutional e-mail sent by the HEIs themselves to their faculty (only four Universities out of the 14 in the Portuguese national HE system did not want to participate in the study). Faculty participated voluntarily in the study. A sample of 444 university and polytechnic teachers was obtained (see Table 1 for sociodemographic characteristics of participants).

3.2. Survey design and procedures

The questionnaire was developed based on the questionnaire applied to students (Aleixo et al., 2021); however, some of the questions were duly adapted and others eliminated. Most of the questions were adapted from the studies by the National Union of Students (2018), Dagiliūtė et al. (2018), and Wang et al. (2020). The modifications made are due to the fact that Aleixo et al.'s (2021) questionnaire concentrates on students' perceptions (e.g., To what extent was SD addressed in your course?), whereas the current questionnaire analyses teachers' perceptions (e.g., To what extent is SD addressed in the curricular unit you teach?). The main differences stem from new issues for teachers that did not apply to students (e.g., the inclusion of SD in the HEI's strategy; the existence of SD training at the HEI). A descriptive question was also included to better define the HEI type - university or polytechnic - in the

Table 1
Sociodemographic characteristics of participants.

		n	%
Gender	Female	240	54.1%
	Male	204	45.9%
Age	20–29 years	11	2.5%
	30–39 years	47	10.6%
	40–49 years	125	28.2%
	50–59 years	174	39.2%
	60–70 years	87	19.6%
Educational system	Polytechnics	285	64.2%
	Universities	159	35.8%
Seniority	9 or less years	84	18.9%
	10 and 19 years	100	22.5%
	20 and 29 years	163	36.7%
	30 or more years	97	21.8%
Scientific areas of the courses	Life and health sciences	121	27.3%
	Exact sciences and engineering	111	25.0%
	Natural and environmental sciences	31	7.0%
	Social Sciences and Humanities	181	40.8%

Note. N = 444.

specific context of Portugal.

The survey was designed to explore HEI teachers' perspectives of sustainability and SDGs by examining their opinion about incorporating and implementing them in HEIs, their understanding of teaching sustainability and SDGs, their perceptions of climate change as well as their participation in activities to promote sustainability.

The first section includes questions on demographic and organizational information (age groups, gender, type of HEI, seniority, and main scientific area). The questions in the second section sought to measure teachers' perceptions of the incorporation of sustainability in HEIs and how it is integrated into their institution's different activities. The aim of the third section was to determine the extent to which sustainable development (SD) is addressed in the curricular units taught. Section four characterizes the level of training in SD provided by the HEI and identifies the most relevant actions to improve students' training in this area. The fifth section measures the level of agreement on different climate change statements. Finally, section six addresses teachers' involvement and participation in sustainability actions in their institutions.

The questionnaire survey was pre-tested by seven teachers and the feedback provided was used to improve the instrument. In general, there were no major doubts or questions raised in the pre-test, although it was mentioned that the length of service of the teachers should be put in intervals. There was also a comment that teachers could have more than one scientific area of teaching, so this question was changed to the main scientific area they're teaching. There was particular concern about the face validity of the questions. The pre-test was carried out with teachers who had already worked on the topic of sustainability. They were then able to provide feedback on whether the questions were relevant for assessing the proposed constructs. The reliability of the scales was assessed after data collection and Exploratory Factor Analysis (see section on statistical analysis).

Data were collected after the study's approval by the Ethics Committees of the Polytechnic of Leiria and submission to the General Data Protection Regulation Office at University of Aveiro. Survey anonymity and confidentially was assured. The respondents (teachers) answered after completing the signed consent form.

3.3. Statistical analysis

Several statistical methods were used in this research. The statistical approach was very similar to that of Aleixo et al. (2021). The choice of statistical analysis was primarily based on the types of questions posed (ordinal or nominal scales).

First, the different sections of the questionnaire with Likert-type scale response options were subjected to an exploratory factor analysis (EFA). The data were extracted with the Principal Component method and the results analyzed after the rotation performed with Varimax with the Kaiser Normalisation method. Before proceeding with EFA, the Bartlett's Test of Sphericity ($\chi 2 = 3917.30$; $p = 0.000$) and the Kaiser–Meyer–Olkin measure of sampling adequacy (0.853; meritorious adequacy, Hair et al. (2006) were calculated. The EFA with the 18 items of faculty perceptions resulted in three factors with eigenvalues greater than one, which explains 59.66% of the variance of the data (Table 2). The factors were interpreted as.

- Factor 1 - Incorporation and promotion of sustainability in the HEI's activities. This factor represents the teachers' perceptions related with the incorporation of sustainability in the strategy and day-to-day activities of HEIs, the integration of sustainability in all courses, in the research as well in cooperation with other organizations in the field of sustainability;
- Factor 2 - Climate change and environmental concerns. This factor represents the teachers' perceptions related with the effects of climate change, its impact on human lives, environmental

Table 2

Results from the exploratory factor analysis of the faculty perceptions about incorporation of sustainability in the HEI's activities and teachers' concerns and activities on the topic (with Principal Component extraction and Varimax with Kaiser Normalisation rotation).

Teachers' perception items	Factor loading		
	1	2	3
Factor 1: Incorporation and promotion of sustainability in the HEI's activities			
My institution incorporates and actively promotes sustainability in its strategy	**.87**	.04	.07
My institution actively incorporates and promotes sustainability in day-to-day campus operations	**.86**	−.02	.05
My institution promotes the active incorporation of sustainability in all courses	**.82**	.00	.14
My institution actively promotes conducting research on sustainability	**.66**	−.04	.27
My institution promotes cooperation with other universities/polytechnics and companies at home and abroad in the field of sustainability	**.67**	−.04	.23
Factor 2: Climate change and environmental concerns			
Climate change will negatively impact me and my lifestyle	.06	**.73**	.03
I am concerned about the effects of climate change	.08	**.75**	.01
Governments from across the world should do whatever it takes to address climate change	−.04	**.73**	−.02
I would vote for a government that increased action to tackle climate change	.01	**.70**	.11
I am quite concerned about the waste of natural resources and the destruction/pollution of the environment	−.06	**.71**	.06
I believe that environmental protection is more important than economic growth	−.09	**.66**	.06
I believe that we must conserve our resources for future generations	.01	**.57**	.01
Factor 3: Participation of HE teachers in activities related to sustainability			
I am actively involved in research projects related to the area of sustainability	.06	.01	**.81**
I am actively involved in the definition of internal strategies that promote sustainable development	.15	.01	**.87**
I am actively involved in the development and/or restructuring of courses related to the area of sustainability	.09	.04	**.86**
I am actively involved in events (congresses, conferences, seminars, conferences, workshops, cycles, forums, etc.) related to the area of sustainability	.10	.04	**.85**
I am actively involved in environmental activities organized by my educational institution	.24	.08	**.78**
I am actively involved in social activities (e.g., volunteering, promoting healthy habits, promoting meetings between employees), organized by my educational institution	.23	.11	**.67**
Eigenvalues	2.31	3.40	5.03
% of Variance	17.94%	18.95%	22.77%
Alpha de Cronbach	0.85	0.81	0.90

Note. N = 444.

protection, conservation of natural resources and Government actions in this domain;

- Factor 3 - Participation of HE teachers in activities related to sustainability. This factor is related to faculty perceptions regarding their own participation in sustainability-related activities (e.g., research projects, internal strategy development, course restructuring, conferences, seminars, social or environmental volunteering).

The survey scales' reliability was examined by conducting EFA on the ordinal items and subsequently testing with Cronbach's Alpha (Table 2). With alphas exceeding 0.8, the scales' reliability can be confirmed.

Second, the data for the scales integrated in the EFA were first analyzed using descriptive statistics methods (e.g., frequencies). The differences in the respondents' gender, age, seniority, scientific area, and type of institution (university versus polytechnic) were then examined. As the variables do not follow a normal distribution within each group, the non-parametric Mann-Whitney Test (for gender, age, seniority, and type of institution) and Kruskal-Wallis Test (for scientific areas) were applied. Where significant differences were found, multiple comparisons were made. In this procedure, the age variable was divided into two groups [20–49 years (n: 183; 41.2%) and 50–70 years (n: 261; 58.8%)] as was seniority [less than 20 years (n: 184; 41.4%) and 20 or more years (n: 260; 58.6%)].

Third, as the remaining questions are nominal scales, descriptive statistics were also used for their analysis (frequency distribution tables). Complementarily, Chi-square tests of independence were performed to test if there is an association between the studied variables and some characteristics of the sample (e.g., gender, age groups, seniority group, type of HEI, and scientific areas of study). In all situations with significant associations between the variables, we also calculated pairwise Z-tests.

Fourth, following EFA results, subscales were constructed on the basis of the factor loadings by taking the mean of items loading on any factor. The subscales were used for cluster analysis which was also carried out. A hierarchical cluster analysis was performed (the Ward method was used as the cluster method and the Squared Euclidean distance was used as the measure of distance) with the three factors identified in Table 1. Through the observation of the Dendrogram, four clusters were identified. Non-parametric Kruskal-Wallis tests were also applied to compare clusters.

4. Results

4.1. Teachers' perceptions of the integration and incorporation of sustainability in HEIs

Regarding the incorporation and promotion of sustainability in HEI activities, most teachers agree (sum of answers of 4 - agree and 5 - strongly agree) that the HEI promotes sustainability in its strategy (n: 260; 58.56%) and in the day-to-day campus operations (n: 242; 54.50%). However, only 32.88% agree (n: 146; 32.88%) that the HEI is incorporating sustainability topics in all courses, 41.21% (n:183) agree that the HEI is actively conducting research on sustainability, and 40.99% (n:182) agree that the HEI promotes cooperation with other universities/polytechnics and companies at home and abroad in the field of sustainability (Table 3). These results do not seem to be influenced by teachers' gender, age, or seniority. However, there is greater agreement among university teachers (compared to polytechnic teachers) that they conduct research in sustainability; this is also true for teachers of courses in the areas of exact sciences and engineering, and natural sciences and the environment. Moreover, the lecturers of the natural sciences and the environment feel most strongly that their HEI promotes cooperation with other HEIs/companies in the field of sustainability.

To strengthen this analysis, respondents were asked how SD is integrated in HEIs (Table 4). Most respondents referred that the integration stems from individual initiatives of teachers and/or researchers or small groups of professors/researchers (n:172; 38.74%), or from initiatives of some faculties, departments, or schools, but not from the whole institution (n:134; 30.18%). Only 71 (15.99%) mention that SD is integrated in the different activities of the institution (teaching, research, campus) in a holistic way, involving the entire institution, and that strategic guidelines from top management were followed. The results suggest that the perception of most respondents is that SD is not incorporated and promoted holistically in HEIs. Nevertheless, there seem to be differences between teachers in polytechnics and universities, as well as between teachers in different scientific areas. Teachers in polytechnic

Table 3

Frequencies and Mann-Whitney or Kruskal-Wallis test results for perceptions about the incorporation of sustainability in HEIs by teachers' gender, age, seniority, type of HEI and scientific area.

Actions by HEIs on SD questions	1		2		3		4		5		Gender	Age	Seniority	Type of HEI	Scientific area
	n	%	n	%	n	%	n	%	n	%	MW p-value	MW p-value	MW p-value	MW p-value	KW p-value
My institution incorporates and actively promotes sustainability in its strategy,	14	3.15	56	12.61	114	25.68	210	47.3	50	11.26	.998	.917	.442	.760	.318
My institution actively incorporates and promotes sustainability in day-to-day campus operations,	15	3.38	58	13.06	129	29.05	204	45.95	38	8.56	.921	.285	.233	.972	.161
My institution promotes the active incorporation of sustainability in all courses,	24	5.41	90	20.27	184	41.44	117	26.35	29	6.53	.574	.696	.396	.768	.614
My institution actively promotes conducting research on sustainability,	25	5.63	87	19.59	149	33.56	127	28.6	56	12.61	.613	.435	.550	.000	.000
My institution promotes cooperation with other universities/polytechnics and companies at home and abroad in the field of sustainability,	32	7.21	58	13.06	172	38.74	143	32.21	39	8.78	.801	.701	.742	.109	.038

Notes: N = 444.1 - strongly disagree, 2 - disagree, 3 - neither agree nor disagree, 4 - agree, 5 - strongly agree. MW - Mann-Whitney test; KW - Kruskal Wallis test.

Table 4

Frequencies and Pearson Chi-square test results for perceptions about the integration of SD into the institution by teachers' gender, age, seniority, type of HEI and scientific area.

The integration of SD into the institution: [a]	Frequencies		Gender	Age	Seniority	Type of HEI	Scientific area
	n	%	χ^2	χ^2	χ^2	χ^2	χ^2
I do not feel that SD is integrated into teaching and research at my institution.	67	15.09	0.54	6.06	6.71	11.27*	22.20**
The integration of SD in the different activities of the institution stems from individual initiatives of lecturers and/or researchers or small groups of lecturers/researchers.	172	38.74					
The integration of SD in the different activities of the institution stems from initiatives of some departments, faculties or schools, but not from the whole institution.	134	30.18					
The integration of SD in the different activities of the institution (teaching, research, campus) is carried out in a holistic way, involving the whole institution and following strategic guidelines from top management.	71	15.99					

Note: N = 444. [a] The number of teachers who selected each answer option is represented by n. Only one option could be selected in response to this question. * p-value <0.05; ** p-value <0.01.

education more frequently report that they do not feel SD is integrated into the HEI's teaching and research; the same is true for teachers in life and health sciences.

4.2. Teachers' perception of SD teaching in their HEI and curricular units

Regarding the approach to SD in the curricular units, 129 (29.06%) of the teachers state that it is largely or widely considered in their curricular units, 251 (56,53%) state it is partly or sporadically considered, and 64 (14.41%) state that it is not addressed at all (Table 5). There is no association between these responses and the teachers' gender, age, seniority or type of HEI, but there is an association with the teachers' scientific area. It is the professors of life and health sciences courses that most frequently state sustainability is only sporadically addressed in

Table 5

Frequencies and Pearson Chi-square test results for questions related with the extent to which SD has been considered in curricular units and in training.

Has SD been covered in your curricular units? [a]	Frequencies		Gender	Age	Seniority	Type of HEI	Scientific area
	n	%	χ^2	χ^2	χ^2	χ^2	χ^2
It is not considered at all in my curricular units	64	14.41	4.95	6.68	8.46	6.65	41.26**
It is sporadically considered in my curricular units	120	27.03					
It is partly considered in my curricular units	131	29.50					
It is largely considered in my curricular units	80	18.02					
It is widely considered in my curricular units	49	11.04					
What training does the HEI provide in the area of SD? [a]	Frequencies		Gender	Age	Seniority	Type of HEI	Scientific area
	n	%	χ^2	χ^2	χ^2	χ^2	χ^2
My HEI does not provide, in any way, training in the area of SD	101	22.70	0.75	5.03	3.19	15.20**	11.64
My HEI provides sporadic or occasional training in the area of SD	254	57.20					
My HEI provides training in the area of SD, on a regular or systematic basis	89	20.00					

Note: N = 444. [a] The number of teachers who selected each answer option is represented by n. Only one option could be selected in response to this question. * p-value <0.05; ** p-value <0.01.

their curricular units.

On the other hand, when questioned about the opportunity that best characterizes the training in SD provided by their institution, 254 (57.21%) of the teachers stated that their HEI provides sporadic or occasional training, 101 (22.75%) stated that no training is provided at all, and 89 (20.00%) stated that HEIs provide training in the area of SD on a regular or systematic basis (Table 5). The teachers in polytechnic institutions tend to state more strongly that the HEI does not offer training in the area of SD.

Still within the scope of the HEI's action for ESD, Table 6 show the most important actions for training students in SD are: actions and initiatives on SD such as conferences and seminars (n: 219; 49.3% of the teachers); integrating students into research projects related to sustainability (n: 178, 40.1%); promoting student participation in practical actions on campus (n: 177, 39.9%), and offering free courses/workshops on SD (n: 174; 39.2%). On the other hand, the introduction of an optional (80; 18.0%) and mandatory (65; 14.6%) curricular unit appears with less expression.

Regarding each teacher's individual involvement in sustainability activities (Table 7), the most significant group of teachers work on sustainability through research projects (n:189 agree or strongly agree; 42.57%) or through participation in events such as congresses, conferences, seminars, and workshops (n:185 agree or strongly agree; 41.67%). Some of the teachers also participate in social activities organized by the HEI, such as volunteering or promoting healthy habits (n:160 agree or strongly agree; 36.04%). Less significant, we find environmental activities organized by the HEI (n:130 agree or strongly agree; 29.28%), the development of internal strategies to promote SD (n:127 agree or strongly agree; 28.60%), and the development/ restructuring of courses in the area of sustainability (n:112 agree or strongly agree; 25.23%). Some interesting associations emerge between these results and the teachers' gender, seniority and scientific area, as well as the type of HEI. Female teachers participate more in events (e.g., conferences, seminars), environmental activities and social activities organized by HEIs in the area of sustainability. Senior teachers tend to be more involved in research projects, course development and events (e.g., conferences, seminars) related to sustainability. University teachers are more involved in research projects in this area. Teachers of Natural and Environmental Sciences are the most involved and participate in all kinds of sustainability-related activities.

Table 6
Frequencies for HEIs' actions for student training in SD.

What the HEI can do to ensure better training of its students in the SD area?	n	% relative to total answers	% relative to total teachers
Streamlining actions and initiatives on SD (e.g., conferences and seminars)	219	17.4	49.3
Integrating students in research projects related to sustainability	178	14.1	40.1
Promoting student participation in hands-on actions on campus	177	14.0	39.9
Offering free courses/workshops on SD	174	13.8	39.2
Encouraging volunteer actions (from internal employees and students) in the community	143	11.3	32.2
Promoting participation in social and environmental campaigns (e.g., saving water; beach cleaning)	135	10.7	30.4
Changing teaching learning methodologies by adopting project methodologies or service learning	89	7.1	20.0
Introducing an optional course unit on SD	80	6.3	18.0
Introducing a mandatory course unit on SD	65	5.2	14.6
Total	**1260**	**100%**	—

Note: N = 444. The teachers could select any topic they wished from a list (3 options), 444 teachers answered the question.

4.3. Teachers' perceptions of climate change and environmental concerns

Regarding climate change and its impact (Table 8), most teachers (n: 388; 87.39%) say that climate change will have a negative impact on them and their lifestyle and 418 (94.14%) of respondents admit being concerned about its effects. There is also agreement that governments should do whatever is necessary to tackle climate change (n: 411; 92.57%) and teachers admit they would vote for a government that stepped up its climate change action (n: 388; 76.13%). Most teachers believe that environmental protection is more important than economic growth (n: 318; 71.62%). The need to conserve our resources for future generations has the most support with 435 (97.97%) in agreement. Female teachers would vote more often for a government that increased its action to combat climate change; they also have a greater tendency to agree that protecting the environment is more important than economic growth, and believe it is important to preserve resources for future generations. Older teachers are the most concerned about the waste of natural resources and the depletion of the environment. Teachers in the life and health sciences express most agreement on governments doing whatever necessary to deal with climate change and protecting the environment being more important than economic growth and they would be more likely to vote for a government that took decisions of this kind.

4.4. Cluster analysis of teachers' perceptions

Following previous work analysing students (Aleixo et al., 2021; Lambrechts et al., 2018; Zsóka et al., 2013), we now investigate whether there are different clusters of teachers in light of their perceptions, representing the distinct perceptions on HEIs' promotion of sustainability, HEI teachers' participation in SD topics and climate change concerns.

A hierarchical cluster analysis was performed with the five factors identified in Fig. 1. Through the observation of the Dendrogram, four clusters were identified. The characteristics and differences in the clusters were then examined. The clusters can be characterized as.

- Cluster 1 (n: 178; 40.09%) - includes teachers who are moderately concerned about climate change and environmental issues but feel that sustainability is seldom incorporated into the strategy and day-to-day activities of the HEIs where they teach. Additionally, this cluster includes those faculty members with the least participation in sustainability-related activities;
- Cluster 2 (n: 110; 24.77%) - includes teachers who are less concerned about climate change and environmental issues (but still quite concerned), who participate moderately in sustainability-related academic activities, and who feel that their HEIs incorporate sustainability to a great extent in day-to-day strategies and activities;
- Cluster 3 (n: 83; 18,69%) - includes teachers who are very concerned about climate change and environmental issues, who participate moderately in sustainability-related academic activities, but feel that the HEIs where they teach do not sufficiently incorporate or promote sustainability in their strategy and day-to-day activities;
- Cluster 4 (n: 73; 16,44%) - includes teachers who refer to the highest levels of incorporation and promotion of sustainability in HEI activities, are very concerned about climate change and environmental issues, and participate actively as teachers in various sustainability-related activities.

5. Discussion

This study presents the results of a questionnaire applied to Portuguese higher education teachers about their perceptions and practices on issues related to sustainability. The findings reported herein, based on teachers' perspectives, could aid HEIs in the planning of the transition to a "sustainable HEI".

Table 7

Frequencies and Mann-Whitney or Kruskal-Wallis test results for teachers' involvement and participation in SD.

Teachers' involvement and participation in SD	1		2		3		4		5		Gender	Age	Seniority	Type of HEI	Scientific area
	n	%	n	%	n	%	n	%	n	%	MW p-value	MW p-value	MW p-value	MW p-value	KW p-value
In research projects related to the area of sustainability	120	27.03	56	12.61	79	17.79	121	27.25	68	15.32	.079	.716	.014	.008	.000
In the definition of internal strategies that promote sustainable development	128	28.83	94	21.17	95	21.40	93	20.95	34	7.66	.164	.681	.269	.760	.014
In the development and/or restructuring of courses related to the area of sustainability	139	31.31	89	20.05	104	23.42	84	18.92	28	6.31	.507	.240	.019	.088	.037
In events (congresses, conferences, seminars, conferences, workshops, cycles, forums, etc.) related to the area of sustainability	102	22.97	57	12.84	100	22.52	133	29.95	52	11.71	.009	.167	.004	.940	.000
In environmental activities organized by my educational institution	117	26.35	80	18.02	117	26.35	97	21.85	33	7.43	.020	.636	.923	.385	.032
In social activities (e.g., volunteering, promoting healthy habits, promoting meetings between employees), organized by my educational institution	105	23.65	75	16.89	104	23.42	124	27.93	36	8.11	.017	.928	.771	.730	.011

Notes: N = 444.1 - strongly disagree, 2 - disagree, 3 - neither agree nor disagree, 4 - agree, 5 - strongly agree. MW - Mann-Whitney test; KW - Kruskal Wallis test.

Table 8

Frequencies and Mann-Whitney or Kruskal-Wallis tests for teachers' beliefs related to climate change and behaviours in the SD domain.

Climate change and environmental concerns	1		2		3		4		5		Gender	Age	Seniority	Type of HEI	Scientific area
	n	%	n	%	n	%	n	%	n	%	MW p-value	MW p-value	MW p-value	MW p-value	KW p-value
Climate change will negatively impact me and my lifestyle	2	0.45	8	1.80	46	10.36	195	43.92	193	43.47	.059	.697	.151	.595	.073
I am concerned about the effects of climate change	3	0.68	4	0.90	19	4.28	177	39.89	241	54.28	.061	.431	.767	.599	.100
Governments from across the world should do whatever it takes to address climate change	2	0.45	10	2.25	21	4.73	121	27.25	290	65.32	.595	.435	.919	.347	.016
I would vote for a government that increased action to tackle climate change	10	2.25	12	2.70	84	18.92	162	36.49	176	39.64	.006	.382	.411	.288	.000
I am quite concerned about the waste of natural resources and the destruction/pollution of the environment	0	0.00	4	0.90	15	3.38	130	29.28	295	66,4	.368	.010	.174	.294	.288
I believe that environmental protection is more important than economic growth	3	0.68	29	6.53	94	21.17	165	37.16	153	34.46	.028	.472	.811	.697	.001
I believe that we must conserve our resources for future generations	1	0.23	1	0.23	7	1.58	97	21.85	338	76.13	.005	.305	.529	.141	.774

Note: N = 444.1 - strongly disagree, 2 - disagree, 3 - neither agree nor disagree, 4 - agree, 5 - strongly agree. MW - Mann-Whitney test; KW - Kruskal Wallis test.

As regards the incorporation and promotion of sustainability in HEI activities, data suggest that most teachers perceive that HEIs strive to integrate sustainability in their strategy and the day-to-day campus operations, but only 16% consider that SD is holistically integrated in the institution. About 30% of the teachers report that they largely or extensively integrate SD in their curricular units, and about 30% integrate it partly. These findings are in line with those of Mondragon et al. (2023), who found that around 71% of teachers incorporate education for sustainability into their teaching, and Fia et al. (2022), who suggest that HEIs are pursuing a variety of strategies at different organizational levels to achieve the SDGs. Nevertheless, different levels of maturity can be observed in the integration of sustainability in HEIs because many lecturers claim actions result from their individual input or from that of lecturers from certain departments/schools. The holistic integration of sustainability involving the whole institution and following strategic guidelines from top management is found in the minority of cases according to faculty members. The lack of a holistic approach to embedding sustainability in HEIs was reported by Pires et al. (2022); the lack of consideration of sustainability in an integrated and holistic approach within the main activities and core business of Portuguese HEIs was also reported by Farinha et al. (2020) and Duarte et al. (2023).

About one third of the teaching staff report the integration of sustainability in all the institution's courses; according to Fia et al. (2022), this is in line with the macro approach being implemented by some HEIs

Factor	Boxplot by Factor and Cluster	Kruskal-Wallis Test	Pairwise comparisons of clusters
Factor 1: Incorporation and promotion of sustainability in the HEI's activities		H(3)=225.06 p=.000	Significant differences between clusters (adj. sig): Cluster 3 – Cluster 1 (p=.030) Cluster 3 – Cluster 2 (p=.000) Cluster 3 – Cluster 4 (p=.000) Cluster 1 – Cluster 2 (p=.000) Cluster 1 – Cluster 4 (p=.000) No significant differences between clusters (adj. sig): Cluster 2 – Cluster 4 (p=.122)
Factor 2: Climate change and environmental concerns		H(3)=29.10 p=.000	Significant differences between clusters (adj. sig): Cluster 2 – Cluster 4 (p=.001) Cluster 2 – Cluster 3 (p=.000) Cluster 1 – Cluster 3 (p=.002) No significant differences between clusters (adj. sig): Cluster 2 – Cluster 1 (p=.382) Cluster 1 – Cluster 4 (p=.076) Cluster 4 – Cluster 3 (p=1.000)
Factor 3: Participation of HE teachers in activities related to sustainability		H(3)=364.83 p=.000	Significant differences between clusters (adj. sig): Cluster 1 – Cluster 2 (p=.000) Cluster 1 – Cluster 3 (p=.000) Cluster 1 – Cluster 4 (p=.000) Cluster 2 – Cluster 4 (p=.000) Cluster 3 – Cluster 4 (p=.000) No significant differences between clusters (adj. sig): Cluster 2 – Cluster 3 (p=1.000)

Fig. 1. Independent-samples kruskal-wallis tests by factor and cluster.
Note: The x-axis in the graphs represents clusters obtained by the Ward method (cluster 1, cluster 2, cluster 3 and cluster 4).

to integrate SDG 4 through teaching. Approximately one third of the lecturers partially address SD issues in their curricular units, while another third address the issue largely or widely; these results are again in line with those of Fia et al. (2022), who show that much of the research addresses the integration of SD in teaching at the micro level, but are lower than those obtained by Mondragon et al. (2023). About two fifths of teachers believe that the HEI does research in sustainability and cooperates with other HEIs/companies in this field; these results are different from those of Fia et al. (2022) who found that the third mission of HEIs and research efforts gained less attention. Despite these results, there is still a long way to go in integrating sustainability into HEIs courses and more attention should be paid to the need to revise educational programmes and research activities to include the SDGs (Leal Filho, Salvia, et al., 2023a).

As mentioned, most teachers referred that the integration did not stem from the whole institution but from the individual initiatives of teachers and/or researchers or small groups of professors/researchers or from initiatives of some departments, faculties or schools. This seems to be the dominant approach internationally, as other studies have also shown that the introduction of the SDGs into the curriculum tends to be

a voluntary initiative by teachers (Leal Filho et al., 2023aa). This is a bottom-up approach to sustainability, which seems insufficient for the adoption of a holistic approach to sustainability in HEIs. Some authors suggest the alternative of a whole-of-university approach (McMillin and Dyball, 2009) or the integration of top-down and bottom-up approaches (Alkhayyal et al., 2019; Sammalisto et al., 2014).

In the scope of the HEI's action for ESD, the most important for training students in SD are actions and initiatives like conferences and seminars; integrating students into research projects related to sustainability; promoting student participation in practical actions on campus, and offering free courses/workshops on SD. On the other hand, the introduction of an optional or mandatory curricular unit appears with less significance (lecturing is the least preferred option). This result is in line not only with the Lozano's study (Lozano et al., 2022), but also with the scoping review by Molina et al. (2023), which shows that the integration of the SDGs in the HEIs is more often done through workshops and courses. However, it is different from the results obtained in Winter et al. (2022) where faculty prefer to teach sustainability through lectures. Lozano et al. (2022) argue that practice-oriented pedagogical approaches rather than lectures will allow for greater engagement from

students. Students also expressed preference for more practical pedagogical approaches such as workshops on SD, practical actions in the field of SD, volunteering in the community and practical on-campus actions (Aleixo et al., 2021); the perceptions of students and teachers in this area are therefore aligned.

Regarding the individual involvement of each teacher with activities in sustainability, the largest group of teachers work on sustainability through research projects or participating in events such as congresses, conferences, seminars, and workshops. Some relevant associations emerge between these results and the gender, seniority and scientific area of the teachers, as well as the type of HEI, with female teachers participating more in events, environmental activities and social activities organized by HEIs in the area of sustainability. Female teachers also would vote more often for a government that increased its action to combat climate change and agree more that protecting the environment is more important than economic growth. Senior teachers tend to be more involved in research projects, course development and sustainability related events. More experienced teachers are the most concerned about the waste of natural resources and the depletion of the environment. University teachers are more involved in research projects in sustainability. Teachers of natural and environmental sciences are (a) the most involved and participate in all kinds of activities related to sustainability, (b) tend to agree more that they carry out research in sustainability (this is also true of teachers of courses of exact sciences and engineering), and (c) feel more that their HEI promotes cooperation with other HEIs/companies in the field of sustainability. A systematic review by Georgiou et al. (2021) also revealed that teachers' educational background influences their perceptions on environmental concerns, so it is not surprising that teachers in the natural and environmental sciences are more actively involved in activities in the area of sustainability. Mondragon et al. (2023) found that teachers in engineering and architecture tend to focus more on environmental awareness and energy issues, while those in social and legal sciences tend to focus more on social engagement issues. Teachers in health sciences are less likely to integrate sustainability into their teaching practices (Mondragon et al., 2023). A study by Bulut (2019) involving pre-service teachers showed that women's awareness of sustainable development and levels of global citizenship were higher than that of their male counterparts. SD competence 'critical thinking and ethics' is addressed more often by women than by men, and men are less likely to integrate sustainability in the classroom (Mondragon et al., 2023). These findings suggest that gender and academic background may influence teachers' concerns and practices in relation to sustainability issues.

The results show some associations with the type of HEI where the lecturer works. University teachers are more involved in research projects in the area of sustainability and tend to agree more that they carry out research in sustainability. Teachers in polytechnic education report more often that they do not feel SD is integrated into the HEI's teaching and research. The teachers of polytechnic institutions state more frequently that the HEI does not offer training in the area of SD. There is a large group of teachers with moderate concerns of sustainability in higher education. To increase practices and perceptions, a more top-down approach will accelerate the process. In Portugal, there are differences between universities and polytechnics in the way institutions approach sustainability (Aleixo et al., 2018aa; Duarte et al., 2023; Fonseca et al., 2018). According to Duarte et al. (2023) and Fonseca et al. (2018), universities have more formal learning courses dedicated to sustainability, which can justify the results obtained in this study.

Most teachers say that climate change will have a negative impact on them and on their lifestyle. They admit being concerned about the effects of climate change, agree that governments should do whatever necessary to deal with climate change and say they would vote for a government that stepped up its action to tackle climate change. This result is similar to the study analysing students (Aleixo et al., 2021). Teachers in the life and health sciences are more sensitive to government actions to fight climate changes and consider environmental protection

to be more important than economic growth. The study by Opuni-Frimpong et al. (2022, p. 1) revealed that "teachers' readiness to educate about climate change was influenced by the subjects they taught" (e.g., most of the non-science instructors did not have in-depth knowledge about climate change).

As in previous studies on students (Aleixo et al., 2021; Ferreira et al., 2023; Lambrechts et al., 2018; Zsóka et al., 2013), the analysis strives to identify different clusters of teachers related with the HEI's promotion of sustainability, HEI teachers' participation in SD topics and climate change concerns. Four clusters of higher education teachers were found. The largest cluster (#1) includes 40% of the teachers; they feel their HEI does little to incorporate sustainability and they themselves seldom participate in sustainability-related activities. This group of teachers is the most sceptical or least concerned about SD. The smallest cluster (#4) includes 16% of the teaching staff; they participate the most in sustainability-related activities and feel their HEI promotes sustainability. Cluster #1 shows similarities with Zsóka et al. (2013)'s 'careless cluster' and cluster #4 with Zsóka et al. (2013) 'active cluster'; however, we should be cautious about comparisons as the latter study examined students and included different questions. The study by Aleixo et al. (2021) found that the cluster closest to the 'careless cluster' included only 8% of students (as opposed to 40% of teachers in the present work), and the cluster closest to the 'active cluster' included 45% of students (as opposed to 16% of teachers herein). This suggests that students may be more involved, more concerned, and more motivated to contribute to sustainability practices than teachers. However, as the indicators measured for students and teachers are different, these results are only indicative and future studies should examine this in greater depth. The difference between students and teachers could also be related to generational differences. Generation Z people are more sustainability oriented than previous generations (Dabija et al., 2019). If student perceptions are stronger than faculty perceptions, then there needs to be more integration at the curriculum level (if sustainability is seen as an essential issue in all subjects) rather than the bottom-up approach of integrating sustainability into HEIs. These results also point to the need to strengthen teacher training in sustainability/SDGs, not only to reduce resistance to tackling such issues, but also to enable teachers to integrate the topic into their teaching activities. Yarritu et al. (2023) and Leal Filho et al., 2023b also highlight the need for training programmes in sustainability/SDGs for HE teachers.

As in other studies (Duarte et al., 2023; e.g., Lozano et al., 2022; Sammalisto et al., 2014), the research shows that SD is being integrated into HEIs but that the level of maturity of the action of the different departments and their members varies. A holistic and integrative vision that would speed up the work and institutionalization of SD in higher education is still lacking. As mentioned in Sammalisto et al. (2014), differences in SD competences continue to be visible. Fia et al. (2022) claim that HEIs do not have a common framework for implementing their Agenda 2030 strategy; the present study analysing teachers perceptions in the Portuguese context also obtains this result. Several studies carried out in Portugal note that the measures introduced in relation to sustainability in HEIs are rather fragmented, and call for Portuguese HEIs to adopt a systemic, continuous and holistic approach to integrating sustainability and the SDGs in teaching, research, campus and outreach (Amaral et al., 2023; Duarte et al., 2023; Farinha et al., 2020). The integration of sustainability in HEIs can also be increased by developing projects that encourage the design and integration of sustainability issues in formal (e.g., course curricula) or non-formal education (e.g., workshops, MOOCs), in research activities, in HEI campus activities, and in relations with society and involving all stakeholders in this process. There are already some good examples in this area (e.g., Pires et al., 2022; Sá et al., 2022). Since the launch of the 2030 Agenda, HEIs around the world have been more dynamic and are implementing many projects, so promising results are expected in the coming years (e. g., EUSTEPs, 2022; GREEN ERASMUS, 2022; Maruna, 2019; SUGERE, 2019; TEDS, 2022; Time2Act@SD, 2023).

6. Conclusion

This work provides an exploratory and descriptive study on the perceptions and behaviours of higher education teachers in sustainability, and on how the topic is being addressed by Portuguese HEIs. Given the networks of professors, researchers and staff that have been set up in Portugal to work on sustainability issues in HEIs (e.g., Sustainable Campus Network, ORSIES), this study has helped to diagnose the state of the art in some of the relevant dimensions of the issue. This work has contributed to reducing the gap identified in the literature, namely increasing knowledge about: (a) the view of higher education teachers on the holistic integration (or not) of sustainability in HEIs, whether at the strategic level or at the level of teaching and research; (b) the ways in which teachers integrate sustainability in their activities; (c) the different teacher profiles (clusters) that exist in Portuguese HEIs, which suggest that HEIs should adopt diversified strategies to increase the integration of sustainability issues in their activities.

The results of this study can be useful for HEI decision-makers to improve the faculty's perception of sustainability and SDGs. HEIs should promote sustainability in all dimensions of their daily practices (economic, social, environmental and institutional) and in their activities (governance, education, research, operations, and community), and they should be committed to promoting sustainability and SDGs. HEI managements should develop strategies to actively incorporate sustainability in their structure and processes (governance level). Sustainability can be included flexibly in the respective curricula at different levels, and different methods used to teach students and encourage innovation (education level).

In light of the new findings of this study, it is suggested that some of the following measures be implemented to improve the integration of SD in higher education and to increase the involvement of teachers in sustainability teaching and research activities. In the future, a more integrated, strategic and holistic approach to the integration of sustainability in HEIs is needed, involving all stakeholders. On the other hand, the training of teachers in sustainability issues and sustainability competences should be strengthened (especially for those who teach in scientific fields where the topic is less dealt with), so that teachers can reinforce the topic in the teaching-learning processes. Training in methodological approaches that are more in line with competences for sustainability (e.g. service learning, project-based learning, participatory and experiential learning) should also be strengthened by higher education institutions. Finally, it is recommended that curricula be revised to ensure that sustainability competences are included in all courses.

This study is not without its limitations. The main ones are: (1) given the national scope of the teachers, the results of this study are only applicable to the Portuguese context; (2) more responses were obtained from polytechnics than from universities; (3) fewer responses were obtained from teachers of science and environmental courses. Future studies could address these shortcomings. Also, further research may explore ways to transition from bottom-up sustainability initiatives towards broader and more inclusive sustainability curricula, comparative analyses of sustainability programmes across multiple higher education institutions, as well as strategies to integrate sustainability education in challenging fields like life and health sciences. In addition to promoting sustainability and achieving the SDGs, HEIs must now be involved in achieving Sustainable and Integral Human Development (SIHD) as a response to new humanism because we all have the same rights. This is also a future avenue of research for HEIs as they are involved in SIHD and the creation of new humanism.

CRediT authorship contribution statement

Susana Leal: Was responsible for the, Conceptualization, Methodology, Formal analysis, discussion and, Writing – original draft. **Ulisses M. Azeiteiro:** Was responsible for, Conceptualization, and, Supervision.

Ana Marta Aleixo: Was responsible for the literature review, data collection, discussion and, Writing – original draft.

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.

Data availability

The authors do not have permission to share data.

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