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Sustainability in undergraduate course curricula at Andalusian (Spain) universities: a critical analysis

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Education is one of the main tools used to implement sustainable development goals (SDGs). Higher education institutions (HEIs) have a major social responsibility regarding sustainability given the relevance and impact of their educational work and the creation of knowledge through their research. Sustainability is promoted and linked to values, teaching-learning methodologies, and studying of global–local problems. Within this framework, the objective of our research is to determine the presence and means by which sustainability appears in the course curricula of university bachelor's degrees of the public universities of Andalusia (Spain). The study used quantitative methodology. As in other studies, major deficiencies have been revealed in terms of the inclusion of sustainability in the universities, determining a limited presence of local problems to address sustainability. Thus, Andalusian universities distance themselves from the society and community in which they exist. This may also limit student knowledge of sustainability issues in which they could potentially be relevant participants.

KEYWORDS

sustainability, higher education, sustainable development goals, course curricula, sustainable values, educational methodologies, global–local development, problems with water

1 Introduction

In this article, we consider sustainability and its presence in the educational curricula of undergraduate courses at Andalusian public universities.

1.1 Sustainability and higher education

Sustainability is currently one of the most prominent topics in public policies, business activities, and citizen opinions, both internationally and locally. Since the past century, technological development has resulted in economic growth and improved quality of life in much of the world's population at levels that could never have been imagined. But this accelerated and uncontrolled growth has had a huge impact on the planet, leading to serious local and global problems that have been included in the United Nation's 2030 Agenda for

Sustainable Development (United Nations, 2015). Sustainability is essential to ensuring a balance between economic development, environmental protection, and social well-being, and therefore, adopting sustainable practices is essential to ensuring a viable future for all forms of life on the planet.

UNESCO (2017) proposed a sustainable development education (ESD) plan to promote the achievement of the sustainable development goals (SDGs), suggesting that all educational institutions (including HEIs) should encourage the development of sustainability competencies so that individuals may reflect on their actions and acquire sustainable lifestyles. Therefore, relevant learning content should be incorporated and learning environments must be created to ensure that skills, attitudes, and values may be acquired to permit sustainable societies. Furthermore, UNESCO advocates the promotion of forms of learning that empower students and are compatible with the promotion of the sustainability principles.

Regarding the treatment of sustainability in higher education, Alm et al. (2022) declare that the integration of sustainability in HEIs course curricula helps students acquire (explicit and implicit) skills related to sustainability, especially if they are linked to real-life experiences that can be applied to their work and personal life. Although the work of HEIs is essential to achieve a sustainable society, weaknesses exist in terms of holistically understanding how to incorporate sustainability proposals (Moreno Pires et al., 2022). Moreover, distinct views exist regarding sustainability, sustainable development, and the functions of universities in their implementation (Stough et al., 2018).

Regarding the distinct approaches to sustainability, some believe that curricula aim to achieve a sustainable future for industry, business, and society (Boron et al., 2017). Applying sustainability criteria and principles generates problems, as many companies claim to be implementing sustainable development when it is not true. Therefore, it is necessary to redefine the concept of sustainable development in a more precise and strict way, balancing economic growth with environmental solutions (Hummels and Argyrou, 2021). Another non-anthropocentric view of sustainability has arisen whereby nature and the planet occupy a central role, with the environment and humans being considered equal elements of an ecosystem (Gibbons, 2020; Sharma, 2020; Cuenca-Soto et al., 2023; Lin et al., 2023; Wallenhorst, 2023).

1.2 How sustainability is implemented in higher education

The implementation of sustainability in Higher Education is very diverse and responds to different ways as well as local cultural, natural and social contexts. Given the breadth with which this topic can be treated, in this section we will only point out some of the forms that we consider most relevant and related to our research, considering how the local environment is the place of our research (Andalusia, Spain) and the Spanish regulations that affect it.

Before the United Nations (2015) agreed on the SDGs and UNESCO (2017) endorsed the ESD goals, the Conference of Rectors of Spanish Universities (CRUE) produced a document entitled "Guidelines for the introduction of sustainability in the curriculum" (CRUE, 2012). These guidelines holistically propose including sustainability and incorporating competencies to ensure

that students learn to think and act with sustainable criteria in a cross-cutting manner in the different degrees and subjects of the Spanish university system. The CRUE document considers it essential to promote a holistic education for students and places special emphasis on values and methodological principles, including complexity, transdisciplinarity, social responsibility, diversity, the culture of peace, etc. The proposal does not specify specific content, but refers to both the global and the local, and does stress the need to identify possible risks, challenges, and impacts linked to sustainability. The proposals of CRUE (2012) on pedagogical methodologies and global-local development are almost coincident with those of UNESCO (2017) to achieve an ESD.

Sustainability and the SDGs are closely related to a series of values that must be considered by the HEIs, including: (a) helping students and communities develop social responsibility and sustainability (Lozano et al., 2017) (b) the commitment to peace and inclusiveness, given that, according to the United Nations (2015), the promotion of peaceful, just, and inclusive societies free of fear from all forms of violence should be encouraged since there is no sustainable development without peace and there is no peace without sustainable development; (c) the promotion of a culture of equity to ensure that no one is left behind, including grassroots equity practices in HEIs in which teacher and student opinions are included to determine content, educational practices, and university policies, with all of this including education in ecojustice (Sharma, 2020).

The inclusion of sustainability in HEIs requires reflection on how to incorporate it within the curricula and programs. Furthermore, ideal methodologies must be determined to work on sustainability within the subjects or courses, including interdisciplinarity and transdisciplinarity, comprehensive training, gender complexity, and perspective. These methodologies are compatible and complementary.

Transdisciplinarity is a tool used to confront complexity in the HEIs (Álvarez-Arregi and Arregit, 2019; García et al., 2019; Geli et al., 2019), and is an appropriate methodology to take on sustainability and its relationship with issues such as equity, plurality, and diversity (Estrada-García et al., 2021). Interdisciplinary methodologies are also being applied in the HEIs to educate on sustainable development and sustainability (Escámez and López, 2019; Simon et al., 2023). Hannon et al. (2018) affirmed that interdisciplinary in higher education, regarding both teaching and research, is effective in challenging the disciplinary limits, so that they may consider complex issues that require the mastery of multiple knowledge areas. The UNESCO (2017) also considers that the implementation of inter- and transdisciplinary pedagogical strategies related to problem-solving is key to promoting sustainable development.

A complex view of reality and comprehensive training in HEIs which includes (in undergraduate university studies) theoretical content related to ethical values and principles, are necessary elements to ensure that graduates, in addition to being specialized in their fields of knowledge, also contribute to sustainability through critical thinking. It will permit them to tackle the ongoing innovations and uncertainties arising in our society which is undergoing rapid change, either acting as professionals or as participatory, reflective, and educated citizens (UNESCO, 2017; Bastianoni et al., 2019; Menon and Suresh, 2020; Kinchin, 2023). Other authors, such as Mena et al. (2021) consider it essential to include ecofeminism as a methodology when analyzing and implementing competencies on sustainability in

higher education, since clearly, the incorporation of the gender perspective in this topic provides a distinct view of the planet.

Another relevant perspective suggests that sustainability should include both global and local (*glocal*) problems, strengthening international collaborations between universities to foster intercultural competence acquisition by students, highly relevant in order to tackle the sustainability issues (Caniglia et al., 2018) and promote global citizenship with learning in real, local contexts (Simon et al., 2023). Furthermore, the OECD (2021), in its proposals for the future of education for 2030, considers the need for education to contribute to building more inclusive, fair, equitable, and sustainable economies and societies; and to this end, considering the relevance of the interrelation of knowledge, skills, attitudes and values, and cultural and local traditions, without losing sight of global problems and challenges.

Among the proposals that favor sustainability is the circular economy, which has become key to waste management and recycling worldwide and also visualizing the unsustainable use of resources (Nguyen, 2023). According to the European Union (2015), the circular economy aims to ensure that materials and resources remain within productive and economic activities and in the use of citizens for as long as possible, minimizing the generation of resources.

Another economic vision committed to sustainability is the blue economy (blue growth), which has a close link to work and commercial activities carried out at sea, but which also includes rivers and water. The blue economy encourages the achievement of two of the SDG objectives: Objective 6 (clean water and sanitation), which seeks to guarantee the availability of water and ensure its sustainable management; and Objective 14 (underwater life), which states that oceans, seas, and marine resources must be preserved and used sustainably to ensure sustainable development.

There are different approaches to the blue economy, both in its implementation and in the content of the fields that it includes, since it is conceptualized and carried out differently in distinct countries and their regions (Wuwung et al., 2022). Numerous positions affect the blue economy, essentially those linked to ecosystems and human and economic activities in the oceans (Voyer et al., 2021; Germond-Duret et al., 2023). Some broader interpretations include sustainable agriculture, complex ecosystems, and waste treatment, thus linking the blue economy to the circular economy and human health (Nikitenko et al., 2022). For others, the blue economy integrates an innovative economy of development that focuses on the maritime economy, which considers the global water crisis and promotes sustainable global development, protecting marine ecology (Wenhai et al., 2019; Voyer et al., 2022).

Regarding sustainability, as argued previously, a balance between the global and the local is recommended. Our research takes place in the local environment (Andalusia), where everything related to water takes center stage. Andalusia is part of Spain, in the south of Europe, separated from Africa by the Strait of Gibraltar which unites the Atlantic Ocean with the Mediterranean Sea. For centuries, its geographic location has provided it with over 800 kilometers of coastline, permitting fishing and major commerce. Its Mediterranean climate, with mild winters, its coasts and beaches, and its cultural heritage, have resulted in intense tourism activity which, as of November 2023, has resulted in over 30 million tourists this year. Visitors as well as the 8.5 million inhabitants of Andalusia create sustainability issues, resulting in the need to provide resources and to manage the waste produced. Furthermore, Andalusia suffers from

periodic droughts, leading to problems of water access and use; an attempt is being made to overcome these deficiencies through the over-exploitation of aquifers, capturing increasingly deeper waters, and through the implementation of facilities to eliminate salt from seawater, with both actions generating environmental problems. During drought periods, like the current one, social confrontations often arise over water use between the agriculture, tourism, economic sectors, and the rest of the population, with other clashes taking place over freshwater ecosystem conservation policies.

The approval of the CRUE guidelines (2012), the UN SGDs (2015) and the ESD objectives (UNESCO, 2017) does not guarantee that they will be implemented in university studies. This is why, in this research we are going to start from the CRUE (2012) guidelines, specified previously, to introduce sustainability in the curriculum of university degrees. For this, we will assume criteria, methodologies, and proposed values, and regarding the contents we focus on some of the most relevant risks, impacts and challenges for sustainability in Andalusia (Spain), linking our research to SGDs (United Nations, 2015) 4 quality education, 5 gender equality, 6 clean water, 8 economic growth, 14 life below water and 16 peace, justice and strong institutions. Therefore, the general objective of this research was to check at what level sustainability competences are included or not in the teaching guides of the 9 Andalusian public universities.

The specific objectives are:

- 1 To determine the percentage in which sustainability competencies are represented in the teaching guides of the 9 Andalusian public universities.
- 2 To test whether there are statistically significant differences in the incorporation of sustainability competencies in the teaching guides between the universities of origin.
- 3 To test whether there are statistically significant differences in the incorporation of sustainability competencies in the teaching guides between the branches of knowledge.
- 4 To check whether there are statistically significant differences in the incorporation of sustainability competencies in the teaching guides, taking together the branches of knowledge and the universities of origin.

When considering the objectives mentioned before, the question arises: Is sustainability being worked on in the public universities of Andalusia by incorporating sustainability competencies into the teaching guides of undergraduate studies?

2 Materials and methods

The methodology used in this research was quantitative. Firstly, a descriptive analysis was carried out (frequencies and percentages) of all the dimensions involved in the research (universities, branches of knowledge, degree and dimensions of the questionnaire). To answer specific objectives 2 and 3, an analysis of variance (ANOVA) was carried out. Finally, for objective 4, a multivariate analysis of variance (MANOVA) was carried out.

To continue to expand on the analysis, a Tukey multiple comparison *post hoc* test was performed to determine if differences were observed between the knowledge branches and the universities. In addition, effect size was calculated using partial eta squared (η_p^2)

for the study of the magnitude of the differences. We also studied the intersection of the branches of knowledge and university of origin using a multivariate test of variance (MANOVA) to analyze whether significant differences existed when considering the two factors collectively. The software used for the data analysis was the SPSS statistical analysis package, version 25 (IBM Corp, 2017).

2.1 Participants

Andalusia (Spain) is home to one private and ten public universities, with nine of the public universities offering undergraduate (Bachelor's) degrees. In 2022, the number of students enrolled in these Andalusian universities totaled 202,992, of which 98.22% study at the public universities included in this study (Ministerio de Medio Ambiente, Gobierno de España, 2022). This study was carried out using a sample selected intentionally from 81 course subjects corresponding to 40 degree programs from 9 public universities. Data collection was carried out by 22 teachers belonging to the research team who were experts in the field of sustainability. The analyzed programs correspond to degrees from the following knowledge branches: Arts and Humanities; Engineering and Architecture; Social and Legal Sciences; Health Sciences; and Sciences.

2.2 Procedure

For this research, 9 public universities in Andalusia were considered (University of Malaga, University of Almeria, University of Jaen, University of Seville, University of Huelva, University of Cordoba, University of Cadiz, University Pablo de Olavide, University of Granada) and 5 branches of knowledge (Arts and Humanities, Health Sciences, Social and Legal Sciences, Sciences and Engineering and Architecture). This limits the generalizability of the results at national the level but offers an insight into the presence of sustainability in these areas through the teaching guides.

A survey technique was used for data collection. Survey for which the existing literature on sustainability and blue entrepreneurship competencies was previously reviewed. (CRUE, 2012; Lozano et al., 2017; Bacigalupo et al., 2022); as well as peer-reviewed articles (García González et al., 2020; Bianchi et al., 2022; Tójar and Estrada, 2022).

The questionnaire was distributed online through Google Forms. Twenty-two professors assigned to the public universities of Andalusia and who are linked to a broader research project participated in the collection of information. These professors analyzed 81 teaching programs from 40 different university degrees. The teaching guides were selected through convenience sampling, based on ease of access.

The items assess the level of presence and how the selected competencies, linked to sustainability, are presented in the course curricula. To do so, a Likert-like scale was created having values from 0 to 4, with 0 implying that there is no reference to the competence; and 4 suggesting that the competences are fully integrated into the course curricula.

The questionnaire also includes items on the types of competencies included in HEI curricula, grouped as follows: general, basic, specific, and transversal. Basic competencies are those that are common to all bachelor's level degrees; general competencies are common to all courses of one degree program; specific competencies are common to

each course of a degree program; transversal competencies are common to all university degrees, but do not appear in a specific topic, but rather, they are present as a work tool and as an interpretation of reality, adding diverse content specific to each degree. The questionnaire was validated by 27 experts in methodology or research, sustainability, and blue entrepreneurship (content validity). This process was carried out following the guidelines recommended by the scientific literature on the subject (Fausto Lizaola et al., 2018; Aranda et al., 2021).

The questionnaire measures sustainability and is made up of three dimensions: values, methodologies and knowledge. To determine the feasibility of performing a factor analysis, the Kaiser–Meyer–Olkin (KMO) test for sampling adequacy (KMO=0.816) and Bartlett's sphericity test was performed, where $\chi^2=989.851$ and there was a significance of $p \leq 0.000$. Therefore, it is a good indicator to perform a factor analysis.

The factor analysis performed with the three questionnaire dimensions explained 70.586% of the total variability; therefore, the results are acceptable. The three dimensions yielded different reliability values, with the environmental knowledge dimension related to sustainability being the most notable, having a Cronbach's alpha of 0.885, followed by the values dimension with a Cronbach's alpha of 0.869, and the didactic methodologies dimension with a Cronbach's alpha of 0.701. This suggested acceptable reliability values.

3 Results

The following table presents the descriptive data of the items, grouped by the three dimensions. The dimensions of the study are as follows: values related to sustainability (culture of peace; diversity/plurality, equity approach, and social responsibility); relevant methodologies to work on sustainability (complexity, comprehensive training, gender perspective, interdisciplinarity/transdisciplinarity) and knowledge about global/local sustainability (environmental quality, blue economy, circular economy, aquatic ecosystems, ecosystems depending on water, problems associated with water).

The results are reflected in the following table (Table 1):

Sustainability is included in over 60% of the curricula and the mean indicates good representativeness in the course programs. The values linked to sustainable development, which we have studied, are included in over half of the analyzed courses. The values having a greater implementation in the curricula are diversity and plurality, which, in addition, also have the highest mean and the value having the lowest representation is culture of peace, with a difference between both of 20.48% of representativeness.

In the factor analysis (ANOVA), in the "values" dimension, statistically significant differences ($p < 0.05$) are found in the culture of peace competence between the University of Almeria and the University Cordoba; and also, between the University of Sevilla and the universities of Malaga, Cordoba, Pablo de Olavide, and Granada.

If considering the equity competence approach, there are differences between the Universidad de Sevilla as compared to the universities of Malaga, Almeria, Cordoba, Pablo de Olavide, and Granada (Table 2).

In the values dimension, statistically significant differences ($p < 0.05$) exist in the diversity and plurality competence between the branches of Engineering and Architecture knowledge and between the Social and Legal Sciences as compared to the Sciences (Table 3).

TABLE 1 Descriptive analysis by dimension and items.

Dimension	Items	% of competences in the guides	\bar{X}	S.D.
Values	Culture of peace	56.63%	2.63	1.09
	Diversity/Plurality	77.11%	2.71	1.13
	Equity approach	57.84%	2.35	0.99
	Social responsibility	71.09%	2.55	1.10
	Sustainability	60.25%	2.54	1.07
Methodologies	Complexity	55.43%	2.26	0.97
	Comprehensive training	54.22%	2.62	0.93
	Gender perspective	62.66%	2.46	1.16
	Interdisciplinarity/transdisciplinarity	68.77%	2.80	1.02
Knowledge about global/local sustainability	Environmental quality	54.22%	2.24	1.02
	Blue economy	22.9%	1.89	1.04
	Circular economy	21.69%	1.88	1.02
	Aquatic ecosystems	14.46%	2.33	1.15
	Ecosystems depending on water	15.67%	2.15	1.06
	Problems associated with water	16.78%	2.28	1.26

TABLE 2 Significant differences between dimension 1/university.

Dimensions	Items	(I) University in which the university degree is taught	(J) University in which the university degree is taught	Difference in averages (I-J)	Error Desv.	Sig
Values	Culture of peace	UAL	UCO	2.1111	0.56453	0.015
		US	UMA	2.7412	0.60925	0.002
			UCO	3.6333	0.72516	0.000
			UPO	3.5500	0.80335	0.002
			UGR	3.1333	0.87457	0.023
	Equity approach	US	UMA	2.1294	0.68724	0.076
			UAL	2.3222	0.68289	0.036
			UCO	3.6000	0.81798	0.002
			UPO	3.1000	0.90618	0.034
			UGR	3.6000	0.98652	0.019

The teaching methodologies selected for the treatment of sustainability are found in over 50% of the programs, with the greatest presence (percentagewise) and the highest mean being interdisciplinary/transdisciplinary methodologies. In the didactic methodologies dimension, statistically significant differences are found ($p < 0.05$) in the “comprehensive training” competence, between the University of Huelva with respect to the universities of Malaga, Cádiz, Cordoba, Pablo de Olavide, and Granada. Given the gender perspective competence, there are statistically significant differences found between the University of Sevilla as compared to the University Pablo de Olavide, the University of Granada, the University of Malaga, and the University of Cordoba, as well as the University of Cordoba with the University of Almeria and the University of Jaen (Table 4).

Likewise, the possible relationship between competencies and their presence in the following knowledge branches has been considered: Art and Humanities; Sciences; Health Sciences; Social and Legal Sciences; and Engineering and Architecture.

Statistically significant differences ($p < 0.05$) are only found in the competence of interrelation of complex ecosystems between the Health Sciences branch as compared to the Sciences and Engineering and Architecture branches (Table 5).

In the dimension of knowledge of global/local sustainability, we find statistically significant differences ($p < 0.05$) between the University of Almeria and the University of Cordoba in the inclusion of environmental quality (Table 6).

Taking into account the branches of knowledge, statistically significant differences exist ($p < 0.05$) in the environmental quality competence between the Social and Legal Sciences and the Sciences and Engineering and Architecture branches. In the aquatic ecosystems competencies (rivers, seas, and oceans) and water-dependent ecosystems, statistically significant differences were found ($p \leq 0.05$) between the Sciences branch as compared to that of Arts and Humanities, Health Sciences, Social and Legal Sciences, and Engineering and Architecture. In issues associated with water, differences existed between the Sciences branch and

TABLE 3 Significant differences between dimension 1/knowledge branch.

Dimensions	Ítems	(I) Knowledge branch	(J) Knowledge branch	Difference in averages (I-J)	Error Desv.	Sig.
Valores	Diversity and plurality	Social and legal sciences	Engineering and architecture	1.3000	0.44166	0.040
			Science	0.036	0.036	0.036

TABLE 4 Significant differences between dimension 2/university.

Dimensions	Ítems	(I) University in which the University Degree is taught	(J) University in which the University Degree is taught	Difference in averages (I-J)	Error Desv.	Sig.
Methodologies	Comprehensive training	UHU	UMA	2.3882	0.71625	0.043
			UCO	3.8000	0.85251	0.002
			UCA	3.8000	0.89042	0.003
			UPO	3.3000	0.94443	0.029
			UGR	3.8000	1.02817	0.017
	Gender perspective	US	UMA	2.4000	0.60570	0.008
			UCO	3.4000	0.72093	0.001
			UPO	2.9000	0.79867	0.020
			UGR	3.4000	0.86948	0.009
			UCO	UAL	-2.2222	0.56124
		UJA	-2.0667	0.57510	0.022	

TABLE 5 Significant differences between dimension 2/knowledge branch.

Dimensions	Ítems	(I) Knowledge branch	(J) Knowledge branch	Difference in averages (I-J)	Error Desv.	Sig.
Methodologies	Complexity	Sciences	Engineering and Architecture	1.3111	0.42227	0.027
	Gender perspective	Arts and Humanities	Engineering and Architecture	1.2810	0.44243	0.045

TABLE 6 Significant differences between dimension 3/university.

Dimensions	Ítems	(I) University in which the University Degree is taught	(J) University in which the University Degree is taught	Difference in averages (I-J)	Error Desv.	Sig.
Knowledge of global/local sustainability	Environmental quality	UAL	UCO	2.0000	0.58958	0.037

that of Arts and Humanities, Health Sciences and Social and Legal Sciences (Table 7).

Upon application of the η^2p statistical test to measure effect size, differences of large magnitudes were found based on the knowledge branches and the distinct universities of origin.

Subsequently, a multivariate factor analysis (MANOVA) was performed, with the dependent variables being the items (competencies) from the questionnaire and the study factors being the university of origin and knowledge branches. For this, the following tests were applied: Pillai's trace, Wilks' lambda, the Hotelling trace criterion, and Roy's largest root. The results show a p -value ≤ 0.05 significance for the intersection of university of origin and knowledge branch. Therefore, there are statistically significant differences (p -value = 0.000) if we consider these factors collectively. The study of the effect size of the intersection of these factors was also performed using the partial eta squared test (η^2p), obtaining a value of 0.844, indicating a major magnitude of the differences observed on the distinct

measurement occasions when collectively considering the university of origin and the knowledge branches.

4 Discussion

4.1 Sustainability

Higher education has a key responsibility to address the major sustainability challenges of our era, through responsible forms of research and education (Tassone et al., 2018). In our study, it is found that sustainability appears in 60.25% of the curricula in an explicit manner, through specific and transversal competencies. The data reflect that in almost 40% of the courses, the curricula do not include sustainability. We have not found statistically significant differences with regard to the presence of sustainability in the Andalusian universities.

TABLE 7 Significant differences between dimension 3/knowledge branch.

Dimensions	Items	(I) Knowledge branch	(J) Knowledge branch	Difference in averages (I-J)	Error Desv.	Sig.
Knowledge of global/local sustainability	Environmental quality	Social and Legal Sciences	Sciences	-1.3944	0.40634	0.011
			Engineering and Architecture	-1.2500	0.42719	0.042
	Aquatic ecosystems	Sciences	Arts and Humanities	1.0952	0.36045	0.032
			Health Sciences	1.1667	0.38712	0.034
			Social and Legal Sciences	1.0167	0.32864	0.028
	Water-dependent ecosystems	Sciences	Arts and Humanities	1.0397	0.34178	0.032
			Health Sciences	1.1111	0.36706	0.033
			Social and Legal Sciences	0.9611	0.31161	0.028

The data we have obtained agrees with other research on the integration of sustainability in Spanish university curricula, concluding that this is taking place very slowly and sparsely and that this makes it difficult for SDGs to be achieved since the graduating students who should be upcoming leaders of society lack adequate training in sustainability (Guerenabarrena-Cortazar et al., 2021). Some causes of this slow incorporation are limited teacher training on the key concepts of sustainability, and to select coherent content, ideal values, methodologies, and evaluation criteria (Antúnez et al., 2017; Escámez and López, 2019; Guerenabarrena-Cortazar et al., 2021; Moreno Pires et al., 2022); and furthermore, the inclusion of sustainability has taken place in a fragmented and optional manner, without making major changes in the curricula offered by the universities (Geli et al., 2019); and for these reasons, an increased institutional commitment is demanded of the universities (Antúnez et al., 2017).

This insufficient incorporation of sustainability does not only affect Spain. O'Byrne et al. (2015) examined 54 English language curricula for bachelor's and master's university degrees, taught in distinct countries, that granted sustainability degrees. They found a great diversity in the curricula, criticizing their inconsistency of content, with the social and natural science knowledge not being appropriately integrated. In another analysis, Franco et al. (2019) mentioned that despite good intent and proposals, the weakness of the HEIs lies in their attempt to respond to the SDGs through political initiatives, curricula, and disperse and isolated practices, which may potentially jeopardize sustainability since they fail to consider the complexity of human and environmental interrelations.

Another factor leading to the poor progress in achieving the SDGs, according to Boron et al. (2017) was that they are not advancing to ensure a sustainable future based on the responsibility of companies and governments. They also criticized the manner by which the HEIs included sustainability in their curricula and management. As an added difficulty, Stough et al. (2018) noted the distinct views of sustainability and sustainable development, also discussing university functions and responsibilities in these areas. Mokski et al. (2023) found that the implementation of sustainability is underrepresented in some knowledge areas, especially the humanities. In our study we have not found statistically significant differences between the branches of knowledge, suggesting that there are no differences

between the humanities and other knowledge areas when considering sustainability.

4.2 Values (social responsibility, equity, culture of peace, diversity/plurality)

Social responsibility has a percentage exceeding 71.1% in terms of presence in course curricula, higher than the percentage of the presence of sustainability. This may be because certain values are fundamental to achieving sustainability and they are also the basis for other human actions and behaviors. Sustainability in HEIs and education in social responsibility are inter-related (Albareda and Alférez, 2016; De la Rosa et al., 2019). However, according to Bokhari (2017), the development of the SDGs is conditioned by the weakness of the HEI culture of social responsibility, which will only be proposals and declarations unless they are linked to mechanisms for their implementation, which include the incorporation of mandatory and elective courses including SDGs and social responsibility.

In our study, equity and the culture of peace are not present in 42.16 and 43.37% (respectively) of the course curricula, and furthermore, significant differences exist between universities and equity between areas of knowledge, all of which suggests the need to improve the presence of both in Andalusian universities. These data are in line with the criticism made by Kinchin (2023), stating that the university focuses on technical solutions and does not address social injustices. Eco-justice is one of the sustainable approaches to combat inequality (Lozano et al., 2019; Lin et al., 2023), which includes equity in human relations, also extending it to nature. Other studies have noted the existence of inequality in the HEIs themselves, which jeopardizes the most disadvantaged students. These authors have proposed that, in order to mitigate this inequality and promote sustainability, thus improving social cohesion, it is important to create inclusive collaboration projects and activities (Cox et al., 2022); these should include distinct perspectives and cultures (Alm et al., 2022). These pluralist approaches are positive means of achieving sustainability according to the meta-analysis of Rieg et al. (2021). Regarding diversity/plurality, this value has the greatest presence (77.11%) in the curricula of the courses taught at Andalusian universities. The inclusion of this value mainly through the transversal and general skills, and its mean of 2.71 indicates that this presence is of high quality.

4.3 Methodologies (complexity, comprehensive training, gender perspective, interdisciplinarity/transdisciplinarity)

The implementation and incorporation of sustainability in higher education teaching curricula entail distinct means of approaching knowledge, with certain key methods that are related to knowledge organization, such as those collected in our study. This includes interdisciplinarity/transdisciplinarity, which are evidenced as relevant methodologies in our studies, being the most frequently implemented methodology, being present in 68.8% of the course curricula and having the highest mean (2.80), implying its good representation in the course schedules. The relevant presence of these methodologies in Andalusian universities provides information on the very argument that [Horn et al. \(2023\)](#) make, noting that interdisciplinary and transdisciplinary designs applied to sustainability education have not been extensively studied, and considering that these methodologies are key for students to address complex sustainability issues and implement good education for sustainability.

Distinct meta-analyses and studies have been performed regarding the importance of interdisciplinarity and transdisciplinarity when considering sustainability. This includes the meta-analysis of [Marins et al. \(2019\)](#) on interdisciplinarity in higher education, which concluded that it is a means of working on knowledge to improve sustainable development and that sustainability proposals must act in an interdisciplinary manner. In another meta-analysis, [Mokski et al. \(2023\)](#) analyzed the use of interdisciplinary studies to implement education content for sustainable development in HEIs and they found that it was mainly implemented via two options: integration in the curricula of already existing courses or inclusion of new education curricula for sustainable development. They suggest that it is timely to simultaneously adopt the two approaches in order to reach students of all academic disciplines, especially the humanities. [Fredman \(2023\)](#) considers that, in order for HEIs to fulfill their commitment to a sustainable future, they must promote interdisciplinarity, both within the institutions themselves and in society in general. Given that teaching cannot be separated from research in the HEIs, it is appropriate to highlight the contribution of [Roux et al. \(2017\)](#) who consider that transdisciplinary research is essential to take on socio-ecological problems and includes processes of co-production of knowledge that produce mutual learning in research teams made up of distinct knowledge areas.

Complexity has a lower implementation (55.43%) than interdisciplinarity and transdisciplinarity, with an average of 2.26, indicating that it is present, but it is not always well represented in the curricula. [Tijmsma et al. \(2023\)](#) link complexity with the principles of transdisciplinary and interdisciplinary as an appropriate means of addressing complex sustainability problems in the HEIs.

The gender perspective is present in 62.66% of the curricula, with a mean of 2.46, indicating a good presence and little dispersion in its presence. It is important to introduce this methodology when working on certain classroom skills since it is a means of achieving economies that benefit all people regardless of their gender.

4.4 Knowledge related to global/local sustainability (environmental quality, blue economy, circular economy, aquatic ecosystems, water-dependent ecosystems, problems associated with water)

Based on the global/local approaches, in our research, we have selected global knowledge such as the blue economy and circular economy, which have a large impact when implemented locally and which, in Andalusia, are highly relevant given its sea and coastline and due to its waste management problems. In addition, local problems of great impact in Andalusia have been incorporated, such as environmental quality; aquatic ecosystems (rivers, seas, oceans); water-dependent ecosystems; and problems related to water.

The data reveal that, with the exception of knowledge of environmental quality, a global topic, that is present in over half of the course curricula, the rest of the knowledge areas have a very low presence: circular economy and blue economy appear in percentages that are slightly over 20%, and the distinct topics on water are between 14.46 and 16.78%. These data are not aligned with the need for higher education, to achieve the SDGs, to attempt to address global problems and agendas in a collaborative manner, considering local agendas ([Saito et al., 2017](#); [Franco et al., 2019](#)). Furthermore, [Franco et al. \(2019\)](#) considered that higher education must promote a sustainability approach in collaboration with external agents (governments, civil organizations, economic sectors) that addresses urgent sustainability issues and facilitates the achievement of the SDGs in their surroundings.

The Sustainable [United Nations, \(2015\)](#) considers the economic dimension of sustainable development, and specifically states that sustained economic growth will be sought that will only be possible if wealth is shared and inequality is combated. Among the proposals having a global/local application is the circular economy, which focuses on promoting innovations to achieve a reduction in production materials; recycling waste, materials, and water ([Cainelli et al., 2020](#)). [De Jesus and Mendoça \(2018\)](#) consider it a socio-technical issue for the conservation of the environment and resources. The circular economy has had little presence in research articles and meta-analyses. [Meseguer-Sánchez et al. \(2021\)](#) mention finding 21 articles on the circular economy between 2015 and 2020. [Rodríguez-Chueca et al. \(2020\)](#) view challenge-based learning as highly useful for working with the circular economy since it has an important connection with the reality and context of university students with the local environment. This affirmation is complemented by that of [Albareda and Alférez \(2016\)](#), who noted that practical, collaborative, and real-life activities favor the acquisition of the sustainability and social responsibility competencies.

On the other hand, the local relevance of the blue economy is reflected even in the name of the Andalusian public institution that is responsible for sustainability, the Ministry of Sustainability, Environment, and the Blue Economy. It is evident that the blue economy is relevant to promoting sustainable development. However, both in the research we found and, in our study, we observed a scarce presence of these subjects in the teaching schedules, with it being the item with the lowest average score in our case. In addition, in more than a third of the curricula, it is included as a specific competence.

The presence of the blue economy in Andalusian universities does not coincide with the needs and demands. Within the context of Spain and the Andalusian ports ([Camarero Orive et al., 2022](#)), the blue economy is a development model adopted by almost all Spanish port

authorities, which specify that, together with the more traditional activities such as fishing and aquaculture, other sectors linked to the blue economy such as biotechnology; research and education (including activities with students and collaborations with universities and research centers); sustainable infrastructures; and gastronomy are all emerging with force. Despite the prioritization of the economic, certain trends are arising that promote the connection between the blue economy and social justice, considering communities, combating inequality, promoting sustainability, and preventing the degradation of coastal ecosystems within the context of climate change (Morrissey, 2021; Voyer et al., 2021; Germond-Duret et al., 2023).

Niner et al. (2022) mentioned the need to include a local contextual development of blue economies to fairly satisfy the needs of all actors, based on sustainable ecological foundations. But they also note the importance of co-production with its international dimension. However, in the blue economy, conflicts arise in coastal communities between the traditional uses of the seas and the new emerging activities such as underwater mining and aquaculture, which generate inequality, labor, and cultural changes (Midlen, 2021).

Tourism also has a huge impact on the coasts and as mentioned previously, it is one of the foundations of Andalusia's economy. However, despite its local and global importance, the meta-analysis on research relating the blue economy with coastal tourism, prepared by Kabil et al. (2021), concluded that the presence of tourism in articles on the blue economy is quite low.

The treatment and work of universities are highly relevant, both in sustainable development and sustainability, at the local and community level, with real-life interventions and community interventions (Albareda and Alférez, 2016; Bokhari, 2017; Lozano et al., 2019; Kinchin, 2023). This encourages students to take care of the environment, being more conscious of the difficulties of individuals in a more vulnerable state by combining academic education with community work (Cuenca-Soto et al., 2023). In addition, Roy et al. (2020) added the need to work on local problems in a collaborative and inter-disciplinary manner; and, Apostu et al. (2024) include, together with the community and the University, companies to achieve harmonious, sustainable development. According to our data, these recommendations have not been implemented in undergraduate university programs. The prevalence of topics linked to water is approximately 15% and with a high mean, indicating a clear and often high-quality presence. However, if we examine the types of competencies where they appear in the curricula, we can see that in over 85% they are considered specific competencies. In other words, they treat content related to water in a clear and sufficient manner, since they are courses related to environmental issues, but beyond these courses, this issue is irrelevant (less than 2%).

5 Conclusion

The presence of sustainability in undergraduate course curricula at Andalusian universities is not sufficiently relevant to promote the achievement of the SDGs. The values and methodologies that are suitable for working on sustainability have similar levels of implementation in the curricula we have studied as those for sustainability, highlighting as positive the high presence of the value of diversity/plurality, exceeding 77%, which reflects the tendency to encourage coexistence. Among the methodologies used, interdisciplinarity/transdisciplinarity stands out,

found to exist in 69% of the course curricula. This prevalence is more in line with the importance attributed to this methodology in numerous studies and research.

Despite the importance of working on sustainability, in the local environment, and with community participation, the presence of local topics of great relevance in Andalusia, within the subject curricula at Andalusian universities remains quite limited. In our study, problems associated with water, aquatic ecosystems, and water-dependent ecosystems have the lowest presence and should be considered as relevant local aspects, given that 28% of the Andalusian territory is considered arid and semi-arid, while 13.5% of its territory is at high risk of suffering desertification (Ministerio de Medio Ambiente, Gobierno de España, 2022).

The conservation of the sea and the strong connection of the blue economy with Andalusia's productive sectors, as well as the relevant local environmental problems taking place on the coast and the seas, all reveal the need to increase the blue economy as a key tool to achieve sustainability. It should clearly have an increased presence (that revealed by our study is quite low) and quality in the course curricula developed at Andalusian universities.

The data from our research indicates that local issues are not considered sufficiently relevant. This lack of involvement distances the Andalusian universities from the communities in which they exist, potentially creating a decreased commitment of students with regard to sustainability, since oftentimes, these students believe that their actions will have little impact on global issues.

As previously mentioned, teacher training on sustainability issues could improve the presence and adoption of methodologies and the inclusion of relevant global/local values and issues in undergraduate course curricula. Furthermore, the Andalusian universities should place greater relevance on local issues, to advance toward improved sustainability.

This research contributes to knowing to what extent teaching guides or programs have implemented sustainability in the universities of Andalusia. However, different practices are susceptible to improvement regarding the significant generalization of the results. On the other hand, teaching guide planning only sometimes responds to what is ultimately worked on with the students, making it necessary to complement this research with the opinion of the university students from the universities studied.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

Author contributions

LA: Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. RR: Conceptualization, Investigation, Supervision, Writing – original draft, Writing – review & editing. JR-A: Conceptualization, Investigation, Supervision, Writing – original draft, Writing – review & editing. EM-R: Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing.

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