Beyond Trends: A Bibliometric Analysis Unveiling the Educational, Psychological, Contextual, and Systemic Dimensions of Sustainability in Higher Education

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ABSTRACT:
This study presents a bibliometric analysis of literature focusing on sustainability in higher education, based on a review of 270 publications indexed in the Web of Science from 2014 to 2024. By employing RStudio and Bibliometrix for the analysis, trends, gaps, and contributions were identified, emphasising the most relevant scientific journals, author productivity over time, institutional and international collaborations, and the most prevalent keywords within the context of sustainable institutions. The study's findings revealed four thematic areas across two axes: one focusing on the educational and psychological dimensions of sustainability and the other on the contextual and systemic factors shaping education for sustainability. This study has contributed to a deeper understanding of the integration of sustainability in higher education. This objective was achieved by presenting a full overview of current trends, existing gaps, and potential future research areas

Keywords: education, higher education institutions, sustainable development, sustainability, systemic factors

1. Introduction

Driven by various institutional levels that seek to align with global interests and challenges, the demand for sustainable development in contemporary society has grown (Wang et al., 2020). Thus, this topic has become increasingly important in global discussions, covering transversally its three fundamental pillars of sustainability—social, economic, and environmental (Null & Asirvatham, 2023). In this context, higher education institutions (HEIs) play a crucial role in this transformation (Olsson et al., 2022; Ferrer-Estévez & Chalmeta, 2021; Chankseliani & McCowan, 2021). In this context, the Sustainable Development Goals (SDGs), particularly SDG 4, which promotes "Inclusive and equitable quality education, and the promotion of lifelong learning opportunities for all", emphasize the importance of training citizens capable of facing current and future

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challenges and encouraging educational models that foster civic responsibility (Abo-Khalil, 2024; Al-Kumaim et al., 2021; Giesenbauer & Müller-Cristo, 2020; Wamsler, 2020).

By aligning themselves with SDG 4, HEIs place themselves at the centre of change initiatives aimed at reducing environmental impact and altering social and economic structures. Specifically, this involves the inclusion of educational programs focused on sustainability, effective management of resources, and incorporation of sustainability into their functions (Bonilla-Jurado et al., 2023; Hallinger et al., 2020). Furthermore, there is widespread academic consensus on the importance of studying sustainability in higher education (Ruiz-Mallén & Heras, 2020; Aleixo et al., 2018). Additionally, the scientific literature also indicates that the results obtained in these studies can serve as important indicators for identifying areas for improvement, especially with respect to interdisciplinary and transdisciplinary interactions (Gorski et al., 2023; Wang et al., 2020).

Sustainability in higher education should not be seen only as an educational practice but also as a constant process that enables the sustainable development of knowledge in different disciplinary contexts (Filho et al., 2025; Al-Kumaim et al., 2021; Abad-Segura & González-Zamar, 2021). This study aims to identify and analyse the lines of research on sustainability in the scientific literature, as well as their trends, relevance and impact. Additionally, we seek to identify the themes that integrate sustainability into students' perceptions and into all the structural and organizational dimensions of higher education. A bibliometric analysis of the bibliographic content published from 2014 to 2024 in the Web of Science (WoS) database was conducted for this purpose.

The adopted methodology facilitates the integration of results from several studies, so patterns, trends and gaps in a specific research field can be identified (Almeida, 2023; Snyder, 2019). Documents were obtained from the WoS database using a set of keywords referred to in the previous literature, namely, the studies by Leal et al. (2024), Al Naqbi & Alshannag (2018), Aleixo et al. (2018) and Dagilute et al. (2018), to illustrate the idea of sustainability in the educational field and to represent global actions in education. Specifically, the keywords selected were "Education for Sustainable Development," "Higher Education Institutions," "Sustainability Perception," "Sustainable Development Perception," "Students Sustainability Knowledge" and "Sustainable Students". The bibliometric review was conducted using RStudio software, following the recommendations of Bhattacharjee et al. (2023) and Aria & Coccurullo (2017).

The results obtained in the first analysis were consistent with those of previous studies (e.g., Leal et al., 2024; Bonilla-Jurado et al., 2023; Alsaati et al., 2020; Wang et al., 2020; Giesenbauer & Müller-Cristo, 2020), reflecting the growing trend of the role of HEIs in promoting content related to sustainable development. Additionally, this trend is substantially concentrated in a group of countries and is practically irrelevant in developing countries. However, one of the main contributions of this research lies in the identification of four major thematic axes, which are later aggregated into two major analytical groups that provide an integrated interpretation of sustainability in higher education. This framework provides an empirical basis that can guide educational policies and institutional decisions, particularly in developing countries.

The structure of the present article is as follows: The subsequent section delineates the bibliometric approach, the formulated research questions, and the methodological

strategy employed for the present study. Section 3 details the core findings, which include identifying asymmetries in the global sustainability research landscape. Section 4 provides a more detailed examination of these findings. This analysis categorizes the bibliometric results into two groups and subdivides them into four key thematic axes. This structured interpretation of the data enables the translation of bibliometric insights into practical recommendations for curriculum co-development, pedagogical strategies, institutional support policies, and mechanisms to foster psychosocial engagement in sustainability practices. By centering the discussion on these educational axes, the article proposes strategies that align sustainability education with localized research priorities and broader systemic challenges. The final section summarizes the key insights, acknowledges the study's limitations, and suggests future research directions.

2. Materials and methods
2.1 Framework of the research methods

This study employed a bibliometric literature approach to evaluate trends in scientific publications on sustainability in higher education. This strategy is notable because it facilitates the analysis of a large set of data and its evolution over time. Thus, the characteristics identified in Table 1, in addition to their proven relevance in similar studies previously conducted (e.g., Almeida and Vieira, 2023; Ellili, 2022; Bhattacharjee et al., 2023; Donthu et al., 2021), were the main reasons for the choice of this approach. Moreover, it is important to emphasize the need for a bibliometric review to assess collaboration between academics and identify trends and research opportunities (Donthu et al., 2021; Dieguez-Santana et al., 2025). For the present study, an analysis of publications related to the subject under study was performed in the WoS database between 2014 and 2024. For the qualitative and quantitative analysis of the extracted data, RStudio 4.2.2, the Bibliometrix package, was used. The choice of this tool was based on its ability previously demonstrated in the analysis of this type of data (Bhattacharjee et al., 2023; Aria & Coccurullo, 2017).

Table 1: Characteristics of the bibliometric review

Characteristics of the bibliometric review	- Follows a protocol that ensures careful planning - Consolidate knowledge in a domain so that future researchers can use state-of-the-art insights - Measures the degree of collaboration between authors - Evaluates the statistical aspects of language and keywords - It allows the researcher to analyse the citation and cocitation processes - Contribute to the exploration of scientific references on a given subject - Emerges from data preprocessing rather than following the investigation process - It quantifies the proliferation of specific domains and the emergence of novel subjects - To help researchers understand the statistical analysis of articles

Although bibliometric analysis does not involve a detailed analysis of the substantial results of a study, it can offer a different research perspective. More specifically, it facilitates not only in-depth analyses of publications that summarize the trends, composition and intellectual structure of a knowledge base (Hallinger et al., 2020) but also the identification of links between articles and the identification of domains on the basis of shares, including keywords, coauthorship and bibliometric links (Bhattacharjee et al., 2023). Thus, within the scope of the present investigation, it is particularly effective in finding answers to the following questions:

- RQ. 1 — What trend has been researched in terms of the perceptions of higher education students about sustainable development over the last eleven years?
- RQ. 2 — Who are the most relevant authors, and what are the main sources in this area of study?
- RQ. 3 — Which types of studies are the most relevant in this field?
- RQ. 4—Which countries lead research in this field of research?
- RQ. 5 — What are the most used keywords?

Authors such as Almeida (2023) and Mora et al. (2020) have emphasized the importance of considering steps such as data acquisition, performance analysis, scientific mapping and visualization as a recommendation of good practices in bibliometric analysis. Thus, for the purpose of the present investigation, the objectives of mapping different methods of analysis, such as trends, selection criteria and keywords, are in line with the following studies (e.g., Rosa et al., 2024; Varadarajan et al., 2023)

## 2.2. Identification, Selection and Collection of Data

To ensure the relevance and robustness of the bibliometric analysis, Figure 1 presents a flowchart summarizing the data collection protocol, including the inclusion and exclusion criteria applied in the selection of relevant studies for analysis (Rocha et al., 2016). The bibliometric analysis was performed using the WoS platform, which is widely recognized for its quality, reliability and rigor in the indexing of scientific publications; this guarantees the methodological robustness and scientific relevance of the selected sample (Almeida & Vieira, 2023; Yan & Zhiping, 2023).

The period of analysis from 2014 to 2023 was defined on the basis of the intensification of the academic debate on sustainability in higher education, especially after the definition of the SDGs under the United Nations 2030 Agenda and the signing of the Paris Agreement in 2015. By including works from 2014, we were able to capture publications that preceded or influenced this new global framework, providing a more comprehensive view of the evolution of the subject over time, and 2024 was an option by the authors to include the last complete calendar year.

The definition and application of the protocol were based on the guidelines established by, among others, authors such as Anantharaman et al. (2025), Belu and Marinoiu (2025), and Dieguez-Santana et al. (2025) for the selection of studies, which made

it possible to carefully identify the most relevant studies on students' perceptions of sustainability, ensuring a solid empirical basis for the analysis of trends, patterns and gaps in the scientific literature. This process ensured the application of strict inclusion and exclusion criteria, in addition to allowing effective visualization of the research patterns present in the literature (Rocha et al., 2016). Although the inclusion and exclusion criteria provided methodological rigor, key limitations must be acknowledged to contextualize the reliability of these findings: (1) the exclusive use of Web of Science (WoS) as the sole database, while comprehensive, may underrepresent interdisciplinary studies and (2) the keyword "Higher Education Institutions" could introduce variability due to differing national interpretations. These limitations are discussed again in the conclusions to clarify the scope of generalizability.

Figure 1: *Data collection protocol*
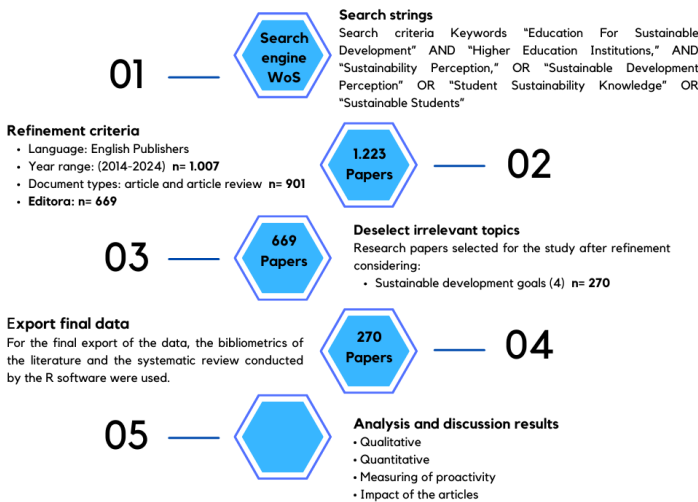
Source: authors' elaboration.

       The WoS survey was conducted in five stages. In the first stage, according to the protocol shown in Figure 1, without applying filters, 1,223 results were obtained by combining the keywords "Education for Sustainable Development," "Higher Education Institutions," "Sustainability Perception," "Sustainable Development Perception," "Students Sustainability Knowledge" and "Sustainable Students." In this first stage, it was assumed that the keywords were used by the authors in the title, abstract and keywords. The criteria were subsequently redefined, with a focus on articles or review articles published in English in the last 10 years (2014-2023), by the publishers MDPI, Elsevier Springer Nature, Emerald Group Publishing, Taylor & Francis, and Frontiers Media Sa. From this analysis, 669 articles were retrieved. Finally, in the third stage, topics considered not relevant to the present study were eliminated, i.e., all those topics that did not meet SDG criterion 4 (quality education). This subtraction resulted in a final sample of 270 publications. After the results were exported, the data were analysed and discussed in the

5th stage. The results were analysed qualitatively through the analysis of keywords and emerging themes and quantitatively through the measurement of the productivity and impact of the articles. This methodological combination aimed to identify the main trends and scientific contributions, offering an overview of the subject under study (Zhao & Li, 2023).

3. Results

This section aims to present and examine the research findings, providing answers to the questions presented above. The systematization of the data facilitates the identification of the changes observed over time, with a special focus on categories such as the number of publications, geographical evolution and scientific mapping, offering a clear view of the evolution and conclusions of the study area.

3.1 Descriptive Statistics

The scientific literature mapping study was based on a combination of descriptive statistics, citation analysis and networks obtained through quantitative data analysis via R Studio software, version 4.2.2. The bibliometrix package, version 4.3, was used. 3., designed for quantitative bibliometric research, allows for the scientific mapping of bibliographic data imported from WoS (Aria & Cuccurullo, 2017).

The descriptive statistical analysis presented in Table 2 shows that the final sample for analysis consists of 270 research studies, covering a period of 11 years (2014-2023). They were prepared by 717 researchers and were published in 61 different publications. In terms of collaboration, 9.25% of the studies were performed under a single authorship regime, whereas 19.83% of the studies involved international collaboration. The calculation of the coauthorship index per article is determined by the average number of coauthors per article, which in this case is 3.24, suggesting a preference for joint studies over individual studies.

Table 2: Descriptive statistics

Data informational	Results
Timespan	2014:2024
Sources (Journals)	61
Documents	270
Annual Growth Rate %	47.88
Document Average Age	3.22
Average citations per doc	10.93
References	12.969
Authors	
Authors	717
Authors of single-authored docs	25
Co-Authors per Doc	3.24
International co-authorships %	19.83

Document types	
article	265
review	5

Source: authors' elaboration based on Soto-Vázquez, R. (2025).

3.2. Analysis of results
3.2.1. Research trends

As shown in Figure 2, the number of annual publications increased between 2014 and 2022, peaking at 61. This was followed by a decline in 2023 (45 publications) and a partial recovery in 2024 (59 publications). However, this trend contrasts strongly with the continuous increase in citation counts during the same period, requiring a more in-depth and holistic interpretation. One possible explanation is the maturation of the field, whereby people increasingly cite foundational studies as benchmarks, signalling consolidation around influential works (Keathley-Herring et al., 2016). Alternatively, the drop in publications could reflect data saturation, with fewer emerging topics and a greater focus on refining established paradigms (Naeem et al., 2024). This aligns with lifecycle models in emerging fields. In these fields, citation growth typically lags behind publication trends by 2 - 3 years (Hallinger, 2020). The 2023 decline could also be the result of constraints on research in the post-pandemic era, with funding and collaboration being disrupted during 2021–2022, which delayed research output (Crawford & Cifuentes-Faura, 2022; Al-Kumaim et al., 2021). While the pandemic presented major challenges to research, such as project interruptions and resource reallocation, its impact on citations may be less immediate as recognition and reliance on prior work continue and intensifies during periods of reduced new content production. The resilience of citations, even in the face of a temporary decline in publications, highlights the robustness and enduring relevance of accumulated knowledge in the field. Although the recovery in 2024 suggests a return to normal, the ongoing increase in citations despite variation in publications may indicate a shift towards focus on quality and influence rather than quantity. This analysis provides the basis for answering the first research question. (RQ. 1 — What trend has been researched in terms of the perceptions of higher education students about sustainable development over the last eleven years?), and it is evident that, in general, the trend of research over the years is increasing.

Figure 2: *Annual publications between 2014 and 2024*
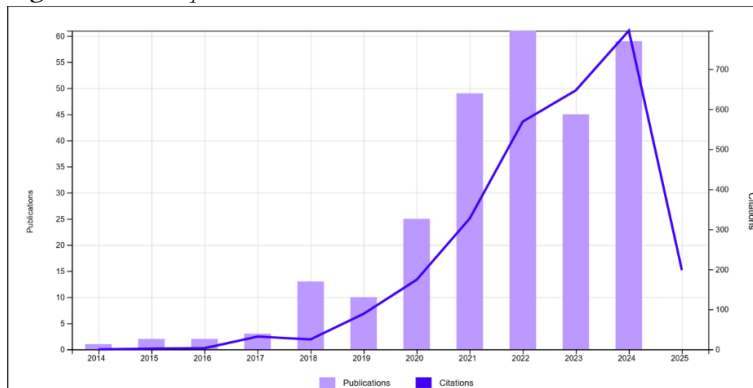
Source: authors' elaboration.

3.2.2. Sources

After the presentation and analysis of the publication and citation trends, the most relevant journals were evaluated, considering the h-index and g-index, as well as the number of publications and citations obtained. The same journals are also analysed by the total number of citations (TCs), by the number of publications (NP) and by the year of publication of the first work on the subject (PY). The fifteen most relevant journals, among the 61 published studies on this topic, are presented in Table 3.

Table 3: Top 15 most relevant journals

Journal	h-index	g-index	TC	NP	PY
Sustainability	17	31	1373	123	2015
Environmental Education Research	7	12	158	13	2017
International Journal of Sustainability in Higher Education	6	12	160	14	2018
Frontiers in Psychology	5	9	84	9	2020
International Journal of Environmental Research and Public Health	3	3	42	3	2021
Cogent Business & Management	2	3	11	3	2022
Education and Information Technologies	2	2	15	2	2022
Education Sciences	2	4	17	5	2021
Heliyon	2	2	21	2	2020
Journal of Applied Research in Higher Education	2	2	19	2	2021

Journal of Cleaner Production	2	2	71	2	2018
Journal of Environmental Education	2	2	124	2	2016
Research in Science & Technological Education	2	2	77	2	2014
Studies in Educational Evaluation	2	2	22	2	2017
Sustainable Production and Consumption	2	2	131	2	2018
Source: authors' elaboration.					

The journal with the greatest number of publications and the greatest relevance is "Sustainability", which, between 2015 and 2024, published a total of 123 studies, with 1373 citations, an h-index of 17, and a g-index of 31. In second place is "Environmental Education Research", which published its first work in this field of investigation in 2017, presenting an h-index of 7, g-indices of 12 and 13 published works. The group of journals that represent 16% of the total sample and 66% of Table 3, all with an h-index of 2, deserves mention. This group includes, for example, "Cogent Business & Management", "Education and Information Technologies" and "Journal of Cleaner Production."

3.2.3. Authors

Table 4 reflects the impact of the authors' publications on the basis of the indicators of the h-index, g-index, total number of citations (TC), number of publications (NP) and year of scientific production start (PY_start). Here, we can observe the most relevant authors and influence our subject of study.

Table 4: List of 15 most impactful authors

Author	h-index	g-index	TC	NP	PY_start
Gericke, M.	5	5	267	5	2014
Abdelsalam, H.M.	3	3	26	3	2021
Jiao, S.	3	3	25	3	2022
Pilotti, M.A.E.	3	3	26	3	2021
Zhang, L.J.	3	3	48	3	2021
Anser, M.K.	2	2	52	2	2020
Berglund, T	2	2	82	2	2014
Boeve-de Pauw, J.	2	2	65	2	2021

Bögeholz, S.	2	2	14	2	2020
Chen, S.Y.	2	2	51	2	2020
Chou, S.F.	2	2	18	2	2019
Colomer, J.	2	2	43	2	2020
De Maeyer, S.	2	2	19	2	2021
El-moussa, O.J.	2	2	22	2	2021
Fiebelkorn, F.	2	2	8	2	2021
Source: authors' elaboration.					

Of the fifteen authors analysed, Gericke M. is the one with the highest h-index of 5. With consolidated production since 2014, which implies 11 years of research in this field, this author has accumulated 267 citations and 5 publications, reflecting a significant and recognized contribution. Next, a group of four authors with an h-index of 3 is represented, constituting 33% of the total number of authors in the analysis. The scientific activity of these authors, which was initiated between 2019 and 2022, has resulted in a citation count ranging from 3 to 26, indicative of a growing impact within the domain. The average number of publications varies between 3 and 5, suggesting that its scientific production is still expanding.

The authors with an h-index of 2 represented 61% of those analysed. With the number of citations varying between 8 and 82 and the number of publications ranging from 2 to 5, they correspond to a more recent production. The majority of the scientific activity of these authors in the field of sustainability began in 2019. Thus, we conclude that there has been a dynamic and diversified evolution in the field, with a balance between established authors and new researchers. This contributes to the continuous advancement of knowledge about sustainability. This analysis, together with that of subsection 3.2.2, allows us to answer RQ. 2 — Who are the most relevant authors, and what are the main sources in this area of study?

3.2.4. Main works and relevance

Table 5 shows the fifteen most relevant studies in this field of investigation. Their analysis is indicative and essential for understanding the evolution of knowledge, identifying gaps in the literature and defining future lines of investigation. The methodology adopted consisted of a summary analysis of the top ten articles, with the number of citations as the evaluation criterion, in particular, more than 50 citations.

Table 5: Fifteen most relevant studies

Author (Year)	Journal	DOI	Total Citations
Lee et al. (2019)	Sustainability	10.3390/su11040985	143
Olsson & Gericke (2016)	Journal of Environmental Education	10.1080/00958964.2015.1075464	120
Al-Kumaim et al. (2021)	Sustainability	10.3390/su13052546	110
Kamenidou et al. (2019)	Sustainability	10.3390/su11030837	91
Al-Naqbi & Alshannag (2018)	International Journal of Sustainability in Higher Education	10.1108/IJSHE-06-2017-0091	89
Ahamad et al. (2018)	Sustainable production and consumption	10.1016/j.spc.2018.06.006	74
Berglund eta al. (2014)	Research in Science & Technological Education	10.1080/02635143.2014.944493	74
Rajapaksa et al. (2018)	Sustainability	10.3390/su10040937	64
Sarmiento et al. (2018)	Sustainable production and consumption	10.1016/j.spc.2018.04.001	57
Olsson et al. (2022)	Environmental Education Research	10.1080/13504622.2022.2033170	50
Goldman D (2018)	Journal of Cleaner Production	10.1016/j.jclepro.2018.02.176	48
Chen SY, 2020	Sustainability	10.3390/su12041374	42
Walshe N, 2016	Environmental Education Research	10.1080/13504622.2016.1221887	41
Asif T, 2020	Sustainability	10.3390/su12073014	40
Liu X, 2020	Frontiers in Psychology	10.3389/fpsyg.2020.01945	40

Source: authors' elaboration.

      A study by Lee et al. (2019) revealed that students express a high degree of concern about environmental issues. However, the authors show that this concern does not always translate into sustainable behaviours, suggesting the need for greater integration of sustainable practices in academic activities.

      In their study on this topic, Olsson & Gericke (2016) focused on the influence of environmental education on the formation of students' sustainable awareness. The

authors' conclusions show that well-structured curricula, with an integrated approach to sustainability, increase students' predisposition to adopt responsible environmental practices. Al-Kumaim et al. (2021) studied the impact of university initiatives on the formation of students' sustainable mindset. In line with Olsson & Gericke (2016), the authors emphasize that universities that integrate ecological practices into their operations and academic programs encourage students to apply these concepts in their personal lives and careers in the future.

In their investigation, Kamenidou et al. (2019) assessed students' degree of knowledge about sustainability and how this perception varies across different study areas. The results indicate that students in courses related to the environmental sciences have a greater level of ecological awareness than do students in management or engineering courses. In the study by Al-Naqbi & Alshannag (2018), the relationship between student participation in sustainability programs and their predisposition towards environmental practices in the future was explored. The authors suggest that a practical and participatory approach may be more effective than the simple theoretical transmission of knowledge.

As demonstrated by Ahamad & Ariffin (2018), with research focusing on the relationship between students' perceptions and sustainable consumption, although many students recognize the importance of sustainability, there are still challenges in translating this attitude into more sustainable behaviours. Accordingly, Berglund et al. (2014) address the role of pedagogical methodologies in teaching sustainability. These authors concluded that interdisciplinary approaches and active teaching practices significantly increase students' interest in the subject. In agreement with the previous author, the study by Rajapaksa et al. (2018), when analysing the factors that influence the sustainable behaviour of university students, concluded that the existence of sustainable infrastructure in institutions has a direct effect on the adoption of ecological practices by students. In line with this line of investigation, Sarmiento et al. (2018) explored the relationship between institutional commitment to sustainability and student motivation. The results obtained showed that HEIs that adopt clear sustainability policies register more significant involvement and commitment on the part of students in sustainable practices. Finally, Olsson et al. (2022) focused on changes in students' perceptions over time. The results obtained indicate that students are more aware of environmental challenges; however, there are still gaps in the practical application of this knowledge. This gap underlines the need for curriculum reform, the adoption of more effective institutional strategies and the promotion of the active involvement of students in sustainable initiatives.

Thus, when the lines of investigation and conclusions of previous studies are compared, three major themes emerge. First, with respect to the relationship between knowledge and sustainable behaviour, most studies highlight that, despite growing environmental awareness among university students, this perception is not always translated into concrete actions. Second, regarding the role of educational institutions in promoting sustainability, the articles analysed here show that universities play a key role in the formation of a sustainable mindset among students. Finally, regarding the importance of active and interdisciplinary pedagogical approaches, the effectiveness of active methodologies, such as interdisciplinary teaching, project-based learning and practical experiences, is widely recognized in the literature. Question RQ3— Which types of studies are the most relevant in this field? — finds the answer in this subsection.

3.2.5. Geographic distribution

Figure 3 illustrates the scientific collaborations between countries, presenting two main categories: publications from a single country (SCP - single country publications) and collaborative publications between multiple countries (MCP - multiple country publications). China stands out as the country with the largest number of publications, with the majority being SCP. However, despite this indicator suggesting predominantly domestic scientific production, China also has the highest MCP. Among the ten countries with the largest number of publications, five are from Europe, with Spain presenting the largest production in this field, and three countries from Asia, North America, and Oceania complete the group with one country each. Figure 4 shows the absence of any African country.
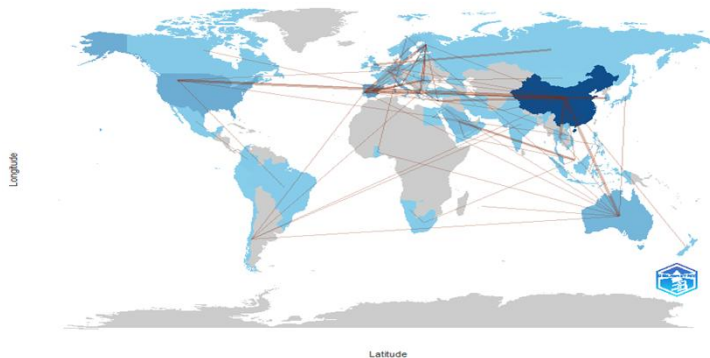
The reduced presence of African countries from the global sustainability research collaboration map is a critical gap that reflects structural inequities in the production and visibility of global knowledge (Frantz et al., 2016). This underrepresentation cannot be considered incidental; rather, it is rooted in systemic barriers, including chronic underfunding, inadequate technical and research infrastructure, and limited access to international academic networks (Hartvigson & Heshmati, 2022; Bothun, 2016). It has been demonstrated that the structural asymmetries in funding, visibility, and institutional capacity not only perpetuate dependency but also pose a significant obstacle to the integration of context-specific knowledge into global sustainability discourses (Hartvigson & Heshmat). Consequently, African institutions have been found to lack the necessary resources to establish competitive research centers or to sustain long-term partnerships without targeted financial support (Mutinda & Liu, 2021).

Addressing this imbalance necessitates the implementation of proactive, evidence-based strategies that foster collaborations. The promotion of North-South and South-South partnerships is of particular significance, specifically when these partnerships are founded on shared agenda-setting, reciprocal resource allocation, and long-term capacity building (Jorge, 2025; Frantz et al., 2016). Initiatives that have been demonstrated to be effective in expanding scientific capacity and strengthening research culture include those that focus on researcher training, the development of clear research policy, and investment in digital infrastructure (Bothun, 2016). In this regard, Mutinda and Liu (2021) demonstrate in their study the potential of such frameworks to bolster the research output and institutional resilience of African higher education institutions. By proactively incorporating African higher education institutions (HEIs) into the global sustainability discourse and prioritizing equity in the conception of collaborative initiatives, the academic community can promote a more inclusive and effective sustainability education (Hartvigson & Heshmati, 2022).

Figure 3: *Scientific collaborations*
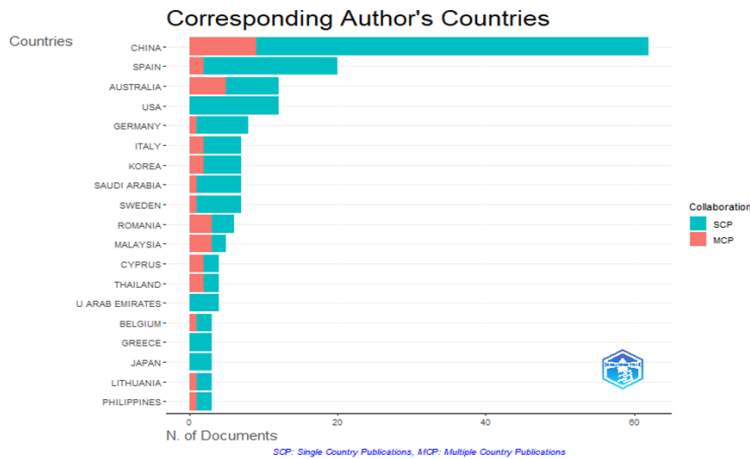
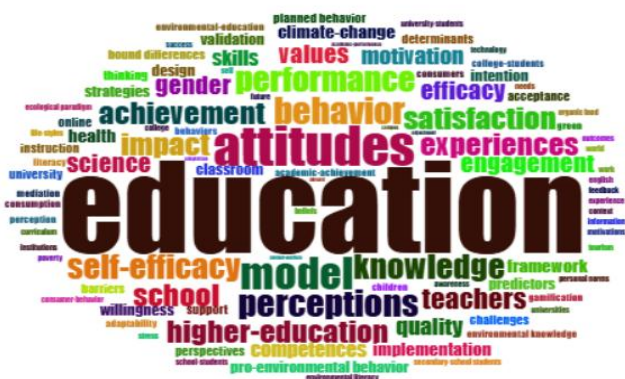Source: authors' elaboration using bibliometric R-studio based on Moresi et al. (2024).

The preponderance of national scientific production in countries such as China can be attributed to policies to encourage local research. Nevertheless, it is important to note that international collaboration plays a crucial role in the exchange of knowledge, cultures and methodologies, driving innovation and promoting scientific advancement on a global scale. In this field, countries such as Spain, the United States of America and Australia demonstrate greater integration of their researchers in collaborative networks. The strengthening of academic networks allows for a greater dissemination of knowledge, resulting in a broader and more significant scientific impact. Figure 4 illustrates scientific collaboration between countries, showing the intensity of the most productive countries through the dark blue colour and the red line, which represents the connection between countries on the basis of frequency and cooperation. The predominance of one-off collaborations (lighter blue colour) and the absence of correspondence with the countries identified in Figure 3 may suggest less consolidated scientific relationships.

Figure 4: *Geographical distribution of published documents*

Source: authors' elaboration using bibliometric R-studio.

The analysis of the geographical distribution of collaborations, illustrated on the map, reveals their scope, which extends from developed economies to developing economies. Again, the low predominance of African nations in this area is noteworthy, which suggests a negligible global exchange of knowledge. On the basis of the conclusions obtained in this subsection, RQ4 is answered: Which countries lead research in this field of research?

3.2.6. Keyword cloud
Figure 5, where the frequency of the keywords is presented, answers the research question (RQ5), which aims to identify the most used keywords. The highest trend and frequency are represented in the figure by the word size.

Figure 5: *Frequency of the keywords*

Source: authors' elaboration using bibliometric R-studio.

The frequency of the terms allows us to conclude that the central concept is education, with 48 occurrences, which highlights the importance of teaching in the investigated context. The emphasis on terms such as attitudes (19), self-efficacy (13), achievement (12) and satisfaction (12) indicates a deepening of the psychological component of learning and academic performance. Pedagogical innovation and teaching methodologies emerge as a second relevant axis, reflected in the terms model (17), perceptions (14), performance (13) and engagement (10). These concepts suggest a growing concern with the effectiveness of teaching strategies and with the need to adapt pedagogical models. The digitalization of education is also evident through the terms technology, online and gamification (3 to 5 occurrences), indicating a trend towards the use of digital platforms and playful strategies to promote student involvement. The third axis, related to sustainability and environmental education, includes the terms climate-change (7), pro-environmental behaviour, environmental-education and green (4 to 7 occurrences). Finally, the analysis reveals concerns about social and behavioural issues, reflected in terms of gender (10), poverty and consumer behaviour (3 to 10 occurrences).

These aspects suggest that the adoption of sustainability cannot be dissociated from socioeconomic factors and inequality in access to environmental education.

4. Discussion of the results

In accordance with previous studies (e.g., Alsaati et al., 2020; Wang et al., 2020), the results obtained in the last ten years identify a gradual increase in the adoption of sustainable initiatives by HEIs. Likewise, the interdisciplinary, multidisciplinary and transdisciplinary approach to education for sustainable development has been used in some studies (e.g., Filho et al., 2025; Leal et al. 2024; Wamsler, 2020; Giesenbauer & Müller-Cristo, 2020). However, after analysing the 270 studies resulting from the bibliometric study, we found that it is possible to classify them into two large groups: Group 1, Educational and Psychological Dimensions of Sustainability in Higher Education, and Group 2, Contextual and Systemic Factors that Shape Education for Sustainability, which are subdivided into four major thematic axes: (i) Psychological Component and Academic Performance; (ii) Pedagogical Innovation and Teaching Methods; (iii) Sustainability and Environmental Education; and (iv) Social Issues and Socioeconomic Behaviour, as detailed in Table 6.

Table 6: Thematic axes

Group	Thematic Axis	Authors	Main Evidence
Educational and Psychological Dimensions of Sustainability in Higher Education	Psychological component and Academic Performance	Lee (2019); Al-Kumaim et al. (2021); Rajapaksa et al. (2018); Olsson (2022); Goldman et al. (2018); Walshe (2016); Asif et al. (2020)	The students recognize the importance of sustainability, but there is a mismatch between knowledge and action. Teacher training can improve students' motivation and perception of competence.
	Pedagogical Innovation and Teaching Methodologies	Olsson & Gericke (2016); Olsson et al. (2022); Berglund et al. (2014); Chen & Liu (2020); Liu et al. (2020); Yang et al. (2021)	The inclusion of sustainability in curricula, combined with active methodologies and educational technologies, improves student engagement and performance.
Contextual and Systemic Factors that Shape Education for Sustainability	Sustainability and Environmental Education	Ahamad & Ariffin (2018); Rajapaksa et al. (2018); Kamenidou et al. (2019); Walshe N, 2016	The perception of sustainability influences academic choices and environmental behaviours. However, institutional and practical barriers hinder

			the effective adoption of sustainable habits.
	Social Issues and Socioeconomic Behaviour	Abad-Segura & González-Zamar, 2021; Chen & Liu, 2020; Yang et al. (2021)	Socioeconomic factors affect the adoption of sustainability, and technology can help democratize access to environmental knowledge.

Source: authors' elaboration.

The first axis, which includes studies such as those by Lee (2019), Al-Kumaim et al. (2021) and Rajapaksa et al. (2018), suggests that, despite the recognition of the relevance of sustainability by students, this recognition does not always translate into concrete and proactive attitudes. This finding reinforces the need for pedagogical strategies that encourage students' autonomy and confidence in their capacity for sustainable action. On the other hand, the axis related to pedagogical innovation and teaching methodologies shows a growing concern with the effectiveness of educational strategies and the adaptation of traditional teaching models. In this context, investigations such as those by Olsson and Gericke (2016) and Berglund et al. (2014) emphasize the importance of the curriculum structure and the implementation of active methodologies in the development of students' environmental awareness. Additionally, a notable focus on the digitalization of education has emerged, promoting greater student involvement through the use of digital platforms and interactive strategies (Yang et al., 2021).

The third axis of analysis, relative to sustainability and environmental education, reflects the growing effort to incorporate environmental issues into higher education, as demonstrated by Ahamad & Ariffin (2018) and Rajapaksa et al. (2018). However, challenges persist that affect the adoption of sustainable behaviours, including issues of convenience and accessibility. The literature highlights the need for institutional policies that favour the incorporation of sustainability both in the academic curriculum and in university infrastructure (Abad-Segura & González-Zamar, 2021). Additionally, social and behavioural dynamics have a significant effect on the adoption of sustainable practices in higher education. Students' perceptions of sustainability cannot be dissociated from socioeconomic factors, as inequalities in access to environmental education significantly affect student involvement, decisively influencing students' sustainable attitudes and behaviours (Abad-Segura & González- Zamar, 2021; and Chen & Liu, 2020).

The analysis of the frequency of terms used in the literature reveals that the intersection between education, psychology, sustainability and technological innovation constitutes an essential multidisciplinary approach for the promotion of education for sustainability. The studies analysed indicate that, for higher education to have a significant impact on the training of environmentally responsible citizens, it is crucial to align curricula, teaching methodologies and institutional policies, supported by effective strategies to promote sustainability.

Studies such as those by Olsson and Gericke (2016) and Olsson et al. (2022) demonstrate an increase in students' environmental awareness, although challenges remain in the transition from awareness to action. This gap highlights the need for curricular reformulation and more effective institutional strategies to encourage the active involvement of students in sustainable initiatives (Berglund, 2014; Sarmiento et al., 2018). In this sense, sustainability in higher education must be manifested not only in theory but also in institutional practices, promoting an ecosystem favourable to the behavioural transformation of students (Filho et al., 2025; Lee, 2019; Al-Kumaim et al., 2021).

Greater involvement of students in extracurricular activities is fundamental for the creation of a sustainable campus (Olsson, 2022). In this context, Al-Naqbi and Alshannag (2018) and Rajapaksa et al. (2018) reinforce the central role of universities in promoting sustainability. This path may involve curricular integration, such as the introduction of specific subjects and active methodologies (Kamenidou et al., 2019). Additionally, the implementation of infrastructure and ecological and institutional policies, such as incentives for the use of sustainable transport and recycling programs, may be crucial factors influencing students' perceptions and sustainable practices, as mentioned previously (Ahamad & Ariffin, 2018).

In summary, HEIs play a central role in promoting sustainability, not only through the integration of environmental content into curricula but also through the implementation of institutional policies and infrastructure that facilitate the adoption of sustainable practices. For this transformation to be effective, a continuous commitment to pedagogical reform is essential to the active involvement of students and to the creation of an academic environment that promotes the transition from awareness to concrete action for sustainable development.

5. Conclusions

The large number of articles published on the subject under study in 2014 and 2024, with continuous growth in scientific production over the past eleven years, was interrupted only in 2023. As previously stated, potential explanations for this scenario may be found in the maturation of the field of research (Keathley-Herring et al., H., 2016), data saturation (Naeem et al., 2024; Hallinger, 2020), or constraints on research in the post-pandemic era (Crawford & Cifuentes-Faura, 2022; Al-Kumaim et al., 2021). The analysis revealed a high concentration of publications in the journals "Sustainability", "Environmental Education Research" and "International Journal of Sustainability in Higher Education", which stand out as the most cited, representing, together, more than 70% of the citations of the 15 journals analysed. Additionally, it is important to note the significant impact of these publications on the h-index and g-index. Thus, its relevance in the academic context is evident. The geographical distribution of publications showed a marked asymmetry in scientific production on sustainability in higher education. According to the data analysed, although China has the largest number of publications, especially with respect to national production, European countries have a significantly greater proportion of international collaborations. Notably, reference to the contribution of developing countries, particularly African countries, to this issue is scarce.

The influence of HEIs in shaping students' perceptions and contributing to sustainable development is widely recognized. However, for this reality to materialize, it is essential that educational institutions more effectively integrate these principles into curricula (Abo-Khalil, 2024; Olsson & Gericke, 2016; Berglund et al., 2014). This reality suggests the need for more effective pedagogical strategies to transform theoretical knowledge into sustainable behaviours. Given the limited number of partnerships, it is imperative to encourage collaboration in the academic context (Findler et al., 2019). Specifically, the importance of these partnerships for the strengthening of multidisciplinary research and for the capacity building of developing countries needs to be emphasized, contributing to the fight against social inequalities and, in particular, to the promotion of compliance with SDG 4 (Jorge, 2025; Abo-Khalil, 2024; Bautista-Cerro et al., 2023; Abad-Segura, E., & González-Zamar, 2021; Ruiz-Mallén & Heras, 2020).

The results that were obtained can provide guidance for public decision-makers, highlighting the need to integrate sustainable principles into academic training, as well as to outline strategies to fill the gaps identified in the research. The integration of ecological practices in curricula, infrastructure and institutional policies has a direct effect on the adoption of sustainable behaviours. These strategies increase student involvement and promote better application of sustainability concepts in academic and professional life.

The findings of this study, which reveal four thematic areas organised around educational/psychological and contextual/systemic axes of sustainability, provide a comprehensive framework for advancing education for sustainability. This comprehensive approach assumes particular relevance when confronted with the persistent gap in the representation of African countries on the global sustainability research collaboration map. The underrepresentation of African countries on the global sustainability research collaboration map, which is rooted in structural inequities such as chronic underfunding and inadequate infrastructure (Frantz et al., 2016; Hartvigson & Heshmati, 2022; Bothun, 2016), highlights the urgent need for models that can be adapted and applied in contexts with limited resources and unique challenges. The model proposed in this work, by addressing fundamental dimensions of sustainability that transcend geographical specificities, possesses the potential not just to guide researchers on the interrelationship and thematic contextualization around sustainability in higher education, but also serve as a valuable tool for developing research capacities and integrating contextual knowledge into global sustainability discourses in African nations. The present study addresses a lacuna in the extant literature and constitutes a step towards more universal research, which is fundamental to addressing global sustainability challenges.

However, the present investigation has several limitations. First, bibliographic analysis, despite its recognition as a method for analysing bibliographic data, allows only a summarized observation of the results of different studies. Second, WoS was used as the only database. Although this database covers a wide range of studies, it may have more limited coverage across disciplines (Hallinger et al., 2020). Furthermore, it should be noted that the choice of the keyword "Higher Education Institutions" can sometimes give rise to mixed results among students in higher education and secondary education because it is applied differently in different national contexts.

To improve our understanding of the shift from awareness to sustainable behaviour in higher education, future research should include studies that examine how

sustainability awareness can be effectively turned into concrete actions. In this context, there is a necessity to explore pedagogies that are student-centred. In addition, the investigation of institutional ecosystems is of equal importance. Indeed, it has been demonstrated that these ecosystems possess the capacity to enhance the ability to act and to transform (Könnölä et al., 2021). In this context, longitudinal studies assume particular significance, as they facilitate the evaluation of the efficacy of these approaches (Steinberg & Schultes, 2025). To conclude, it is imperative to recognise that in order to align educational practices with SDG 4 and the mission of higher education to tackle global challenges, it is essential to understand the mechanisms that support sustainable action.

Future studies should integrate other databases and that allow exploration of new research trends. Hence, Future research should thus investigate whether the citation trend reflects healthy consolidation or points to a need for renewed conceptual and methodological innovation in sustainability education. Furthermore, the way in which institutions, particularly HEIs in underdeveloped countries, conceptualize sustainable development should also be examined. Additionally, we suggest that studies that demonstrate local and international collaboration in all aspects of sustainability implementation should be conducted. Furthermore, while the present study corroborates earlier findings concerning student perceptions of sustainability in higher education, it also highlights a critical issue related to integration at the policy level. The bibliometric work developed can serve as an instrument to inform government action and international educational frameworks aligned with the SDGs. Consequently, the correlation between empirical evidence on student engagement and broader governance models represents a area for future investigation, particularly at the intersection of education policy, political science, and public administration.

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