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Curricularizing environmental education in higher education: Bibliometric evidence and a didactic strategy framework

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ABSTRACT

Environmental education has gained visibility in higher education, yet it is still seldom treated as explicit curricular content that can be deliberately planned, taught, and assessed. This study examined how the literature addresses environmental education in curricular terms within higher education and, based on that evidence, proposed a didactic strategy framework for its systematic integration across disciplines. A two-stage exploratory-descriptive design combined a structured literature review with Scopus-based bibliometric mapping for 2020–2026. Records were analyzed to identify publication dynamics, thematic trends, and collaboration patterns, and VOSviewer was used to visualize the main networks of the field. The findings show that studies explicitly linking environmental education, curricular content, teaching strategies, and higher education remain limited in the indexed literature. Although the broader field has become more visible, it still shows fragmentation and limited guidance on curricular integration, instructional sequencing, assessment, and faculty preparation. The study proposes a didactic strategy framework organized around theorization, methodological planning, faculty training, research, and monitoring and evaluation. Overall, the results indicate that curricularizing environmental education requires clearer pedagogical decisions, stronger institutional coordination, and sustained faculty support.

Contribution/Originality: This study contributes to the literature by examining environmental education as explicit curricular content in higher education and by proposing a didactic strategy framework grounded in bibliometric evidence and interpretative synthesis. It is one of the few studies linking environmental education, curriculum design, and implementation in university settings.

1. INTRODUCTION

In universities, social and ecological crises have imposed new demands, especially regarding the way these institutions understand their role in teaching and their responsibility toward contemporary problems; because of this, environmental education has gained more space within higher education. They are also expected to help students understand environmental problems, reflect on their implications, and respond to them in an ethical and professionally

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meaningful way. In this context, education for sustainable development cannot remain only at the level of institutional discourse. It needs to appear in the curriculum, in the content students work with, in the way learning activities are organized, and in the criteria used to evaluate what has been achieved (Bianchi, Pisiotis, & Cabrera Giraldez, 2022; UNESCO, 2022). Previous studies have shown that higher education institutions can contribute to the development of sustainability competencies. However, this contribution depends on how those competencies are incorporated into curriculum design, learning outcomes, pedagogy, and assessment (Barth, Godemann, Rieckmann, & Stoltenberg, 2007; Svanström, Lozano-García, & Rowe, 2008; Wiek, Withycombe, & Redman, 2011).

Even so, moving from institutional commitment to actual curricular practice remains difficult. Sustainability and environmental concerns are now widely present in higher education discourse, but this visibility does not necessarily lead to well-defined curricular implementation. In many universities, these concerns are acknowledged in mission statements, policy documents, or general curricular orientations, while remaining only loosely connected to course content and classroom practice (Lambrechts, Mulà, Ceulemans, Molderez, & Gaeremynck, 2013; Lozano et al., 2015; Vargas, Lawthom, Prowse, Randles, & Tzoulas, 2019). This gap from institutional intent to teaching and learning has been linked to inconsistent discipline-wide implementation, inadequate faculty preparation, and a lack of precision regarding how sustainability content should be structured and assessed in practice (Busquets et al., 2021; Wang, Sommier, & Vasques, 2022).

What is at stake, then, is not merely the presence of environmental themes, but the way they are incorporated into the curriculum. So, it is about adding real topics and not only adding them, and these decisions must stay coherent with the social role of the institution, and professional training. For this, it is necessary to decide how that content will be framed, with the aim of assessing where it actually fits within the program and what its real purpose is. Also, it must be noted that this approach requires a specific pedagogical focus to teach it. From this didactic perspective, content cannot be reduced only to a list of topics. This is because it must include knowledge, skills, and values that students can actually use and transfer (Álvarez de Zayas, 1999). From a didactic perspective, it is important to understand that content cannot be reduced to a simple list of topics. Since it must include the knowledge, skills, values, and forms of action with which students are expected to engage, develop, and transfer. This in relation to broader educational goals (Álvarez de Zayas, 1999). In the field of higher education, these decisions must also remain coherent and in accordance with professional training and the broader public role of the university.

This issue is especially significant in environmental education. The field has achieved strong conceptual visibility, but that progress has not always been matched by the same level of curricular precision. Research on sustainability competencies has advanced considerably and has offered useful frameworks for identifying the capabilities that universities are expected to foster in students (Annelin & Boström, 2023; Brundiers et al., 2021; Cebrián, Junyent, & Mulà, 2020). Studies in higher education have also highlighted the value of problem-based learning, interdisciplinary pedagogies, and engagement with real-world contexts for sustainability-oriented learning (Brundiers & Wiek, 2013; Rey-Garcia & Mato-Santiso, 2020). However, there is still less work on how environmental education itself is defined and maintained as explicit curricular content that can be planned at the course level, developed through coherent teaching approaches, and assessed across programs and disciplines.

This limitation can be observed both internationally and in Latin American contexts. Recent studies show growing interest in the relationship between sustainability, curriculum, and higher education, including research on competency-based education and curricular reform (Domínguez, Villar, Vizarreta, Espinoza, & Urbano, 2024; Gómez, Prado, Enciso, Tenorio, & Pozo, 2024; Navas-Ríos & Ospina-Mejía, 2020; Polanco & Mayorga, 2025). At the same time, work on environmental representations and academic production in Mexico suggests that environmental issues are increasingly discussed in higher education, yet often without sufficient clarity regarding how they become explicit curricular content in university teaching practice (Arias Ortega, 2025; Calixto, 2025). The challenge, therefore, is no longer only to affirm the academic importance of environmental education, but to clarify how it can be organized, implemented, and evaluated within higher education curricula.

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This is exactly why didactic design is so crucial. Teaching strategies, in the end, are what really decide how content is selected, organized, and assessed. In this aspect, didactic design becomes important, since teaching strategies are inputs to select, organize, and evaluate the content; it is for this reason that, in reality, environmental education stays as a general aspiration, or it becomes a meaningful learning experience. Regarding pedagogical practice, the literature suggests that real learning should focus on: a) coherent planning, b) solid alignment between all the components involved, c) approaches capable of linking knowledge with participation, and d) reflection and action (Arboleda, 2021; da Cruz Nogueira, Vogado, Malcher, & Rezende, 2024; Herrera & Villafuerte, 2023). On one side, in the field of sustainability, it is especially relevant, and on the other side, environmental content usually demands interdisciplinarity and a way of learning that goes beyond the simple transmission of information, with orientation toward a critical commitment (Leal Filho, 2000; Shutaleva, 2023).

In this context, the problem analyzed here is more specific than the simple absence of environmental education in higher education. The central issue lies in how limited and, frequently, fragmented its consideration is as explicit curricular content, that is, as something that can be developed, taught, and maintained intentionally through different disciplines. Although much of the literature supports sustainability from discourses of "principles" or "competencies", very few studies offer operational models that allow for turning environmental education into a structured didactic category. This lack of structure ends up weakening curricular coherence and makes it difficult for institutions to translate their commitments to sustainability into a stable and everyday educational practice.

To address this gap, the study examines how the literature has treated environmental education as a curricular element, aiming to propose an integrated didactic framework that contributes to its systematic incorporation within the university; for this, a structured literature review and Scopus-based bibliometric mapping were used for the years 2020–2026, and this evidence is the input to build a model composed of interconnected elements. The main contribution of this work consists of articulating the bibliometric evidence with the practical curricular design. The goal is to move beyond the general calls to sustainability and propose an explicit, evaluable, and applicable model that allows for curricularizing environmental education in higher education.

2. METHODOLOGY

This study followed an exploratory-descriptive design that combined three linked parts: a) a structured literature review, b) Scopus-based bibliometric mapping, and c) framework development. The purpose of this design was twofold. First, it sought to identify how environmental education has been addressed as curricular content in higher education. Second, it used that evidence to build a didactic strategy framework for more systematic curricular integration. This combination was considered appropriate because the study was not limited to just describing publication patterns. Actually, it also aimed to identify recurring curricular and pedagogical gaps. Then, it focused on translating them into an operational proposal for higher education practice (Bianchi et al., 2022; UNESCO, 2022).

2.1. Structured Literature Review and Data Sources

The evidence base was put together through a structured review. This review included journal articles and doctoral theses. I used Web of Science, Scopus, Google Scholar, and TDX. These sources helped with: 1) conceptual clarification, 2) theoretical triangulation, and 3) synthesis. And Mendeley was used only for references and duplicates.

Also, the bibliometric part was only for Scopus. Therefore, the study analyzed publication patterns, themes, and networks in that database alone, aiming to maintain consistency and make the indicators more comparable and reproducible. For that reason, the executable search strings reported in Table 1 correspond only to the Scopus searches used for bibliometric analysis. WoS, Google Scholar, and TDX served as complementary sources for the broader literature review rather than as part of the bibliometric measurement itself.

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2.2. Scopus Search Strategy

The Scopus search was designed to map the literature published between 2020 and 2026 through two analytically distinct extractions, both carried out in February 2026: (a) a refined baseline dataset focused on didactic strategy in relation to environmental education, curriculum, and higher education; and (b) a broader environmental education-focused dataset used to characterize the field in higher education.

These datasets were analyzed separately and were not merged. The refined baseline dataset was intended to capture the narrower intersection among didactic strategy, curricular content, and environmental education in higher education. The second dataset was used to describe the broader research landscape. A third, high-sensitivity complementary search was also conducted to assess wider thematic coverage, but it was not incorporated into the final analytical corpus. This decision was consistent with international ideas. These views focus on curricular integration and building competencies. This is key for sustainability learning in universities (Bianchi et al., 2022; UNESCO, 2022).

In this process, the search covered TITLE-ABS-KEY fields using Boolean operators, phrase searching, and truncation for the different terms, while excluding records about primary or secondary schools to keep the focus on higher education. Consequently, the study left out K–12 and early childhood contexts, applying filters for document type and language to keep only articles or reviews in English or Spanish. The full search strings, their analytical role, and the corresponding number of retrieved records are presented in Table 1.

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Table 1. Scopus search strategy (TITLE-ABS-KEY), analytical role, constructs captured, and executable query strings.

Search ID	Analytical role in the study	Main constructs captured	Query string (Executable in Scopus)	Time window	Filters/exclusions	Records retrieved
String 0 (Refined)	Baseline dataset for didactic strategy in the context of EE/ESD and higher education	Didactic strategy; higher education; curriculum/Curricular content; EE/ESD	TITLE-ABS-KEY(("didactic strateg*" OR "teaching strateg*" OR "instructional strateg*") AND ("higher education" OR universit* OR "tertiary education" OR college) AND (curriculum OR curricular OR syllabus OR "course content" OR "teaching-learning") AND ("environmental education" OR "education for sustainable development" OR ESD OR "sustainability education" OR "education for sustainability")) AND PUBYEAR > 2019 AND PUBYEAR < 2027 AND NOT TITLE-ABS-KEY("primary education" OR "secondary education" OR K-12 OR "early childhood") AND (LIMIT-TO(DOCTYPE, "ar") OR LIMIT-TO(DOCTYPE, "re")) AND (LIMIT-TO(LANGUAGE, "English") OR LIMIT-TO(LANGUAGE, "Spanish"))	2020–2026	Articles/reviews only; English/Spanish; excludes K–12 and non-tertiary contexts	13
String 1	Primary EE retrieval corpus	EE/ESD; curricular content; didactic strategy; higher education	TITLE-ABS-KEY(("environmental education" OR "education for sustainable development" OR ESD OR "sustainability education" OR "education for sustainability") AND ("curricular content" OR curriculum OR curricular OR "course content" OR syllabus OR "curriculum integration" OR "curriculum design" OR "curriculum development") AND ("didactic strateg*" OR "teaching strateg*" OR "instructional strateg*" OR pedagogy OR pedagogical OR didactic* OR "teaching-learning" OR "teaching and learning") AND ("higher education" OR universit* OR college OR "tertiary education" OR undergraduate OR graduate OR "teacher education" OR "faculty development")) AND PUBYEAR > 2019 AND PUBYEAR < 2027 AND NOT TITLE-ABS-KEY("primary education" OR "secondary education" OR K-12 OR "early childhood")	2020–2026	Excludes K–12 / non-tertiary contexts	428
String 2	High-sensitivity complementary search used to assess broader thematic coverage	EE/ESD; curriculum integration; higher education	TITLE-ABS-KEY (("environmental education" OR "education for sustainable development" OR ESD OR "sustainability education") AND ("curricular content" OR curriculum OR curricular OR "course content" OR syllabus OR "curriculum integration") AND ("higher education" OR universit* OR "tertiary education" OR "teacher education" OR faculty)) AND PUBYEAR > 2019 AND PUBYEAR < 2027 AND NOT TITLE-ABS-KEY ("primary education" OR "secondary education" OR K-12 OR "early childhood")	2020–2026	Excludes K–12 / non-tertiary contexts	1,112

Note: Searches were executed in Scopus using Boolean operators (AND/OR/NOT), quotation marks for phrase searching, and truncation (*) to capture term variants. Consequently, the refinement of String 0 improved thematic specificity, aiming to align the baseline dataset with the focus on higher education and curricular content, including concepts related to EE and ESD. In this sense, String 1 served as the primary corpus for EE retrieval, while String 2 functioned as a high-sensitivity search to assess broader thematic coverage, allowing for a separate analysis of the EE datasets without merging them.

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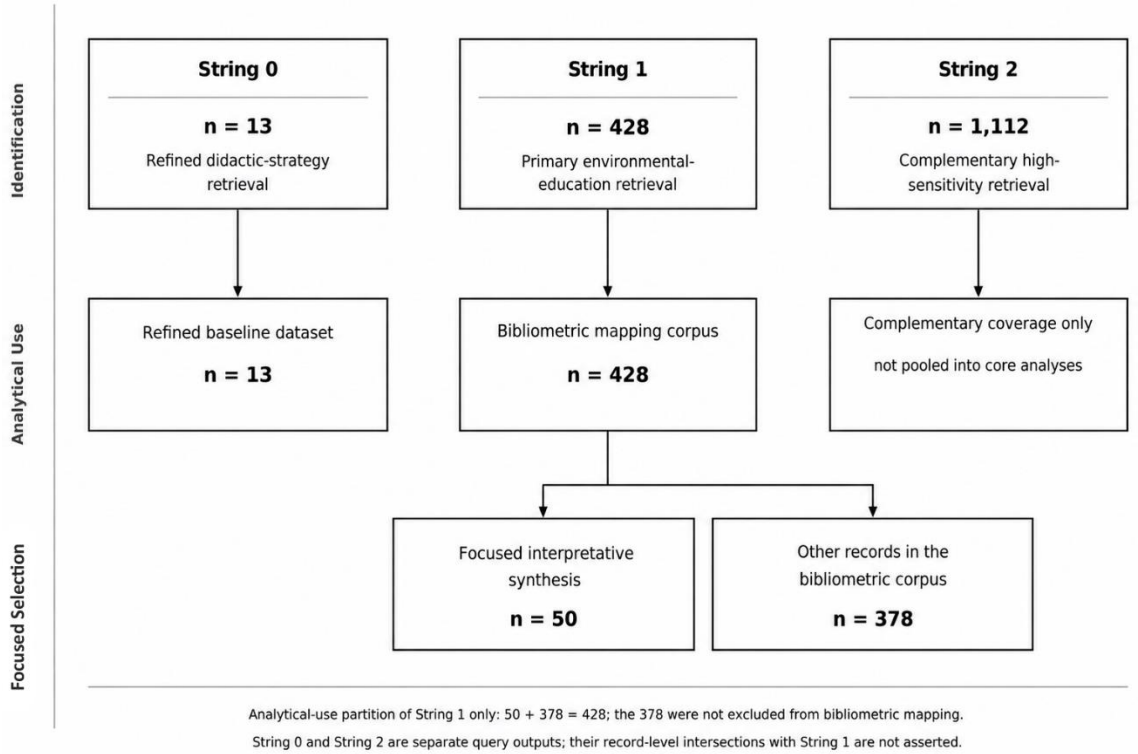
2.3. Complementary Searches

Furthermore, the search extended to Web of Science, Google Scholar, and TDX, ensuring a broader coverage of the academic production. Their goal was not bibliometric. I used them for identification and theoretical triangulation. These sources helped me find extra materials. Many were not found in Scopus. Therefore, their role was conceptual and interpretative. It was not a statistical role. This distinction is important because the bibliometric conclusions reported in the article are based exclusively on Scopus, whereas the wider literature review informed the interpretative and conceptual development of the proposed framework.

2.4. Eligibility Criteria and Screening

All Scopus records were exported in CSV format, including bibliographic metadata such as authors, affiliations, source titles, year of publication, citation counts, author keywords, and cited references. Records were included when they met three criteria: (a) they addressed environmental education and/or education for sustainable development in higher education contexts; (b) they linked those topics to curriculum, curricular content, or course-level implementation; and (c) they provided sufficient metadata for bibliometric processing. Records were excluded when they were duplicates, when they did not focus on higher education or curricular integration, or when they corresponded to non-research items such as editorials or notes. Duplicate removal was carried out in Mendeley and checked manually when necessary. These criteria were intended to keep the final corpus aligned with the study objective, particularly emphasized curricular implementation in higher education and the need for evaluable approaches to environmental education integration (Luna-Krauletz, Juárez-Hernández, Clark-Tapia, Súcar-Súccar, & Alfonso-Corrado, 2021).



Note: The query-specific outputs were analyzed for distinct purposes and were not consolidated into a single documented PRISMA screening pool. String 0 retrieved the refined didactic-strategy baseline (n = 13). String 1 supplied the primary bibliometric corpus (n = 428), including the focused interpretative subset (n = 50); the remaining 378 records belong to the broad bibliometric corpus but not to the focused interpretative subset. String 2 retrieved 1,112 records for complementary thematic coverage. The 378 are not a documented set of exclusions from the bibliometric analysis. The diagram does not claim cross-search duplicate removals or absence of bibliographic overlap among the search outputs.

Figure 1. PRISMA-style flow diagram of Scopus record identification, screening, and inclusion.

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To make the screening process transparent, the Scopus datasets were organized through a PRISMA-style workflow. String 0 produced 13 records, String 1 yielded 428 records, and String 2 retrieved 1,112 records, for a total of 1,553 initially identified records. After consolidation, 1,269 duplicate or overlapping records were removed. The remaining 284 records were then screened for thematic alignment with the objective of the study, and 105 were excluded because they did not meet the inclusion criteria. The final analytical corpus retained 13 records for the refined didactic-strategy baseline dataset and 50 records for the screened analytical subset of the environmental education corpus. The high-sensitivity search was kept only as complementary retrieval evidence and was not incorporated into the final analytical corpus. The sequence of identification, screening, exclusion, and inclusion is presented in Figure 1.

The Scopus searches served distinct analytical purposes rather than constituting a single pooled screening workflow. String 0 retrieved 13 records for the refined didactic-strategy baseline. String 1 retrieved 428 records for primary bibliometric mapping, of which 50 were retained for focused interpretative synthesis according to the eligibility criteria described above. The remaining 378 records remained within the broad bibliometric retrieval but were not part of the focused interpretative subset. String 2 retrieved 1,112 records for complementary high-sensitivity thematic coverage and was not included in the core analyses. Figure 1 presents these query-specific retrievals and the analytical-use partition of String 1 in an adapted PRISMA-style format. The three search counts are not summed as a deduplicated corpus, and the 13-record baseline and 50-record subset are not treated as confirmed mutually exclusive document sets.

2.5. Analytical Levels and Framework Derivation

The literature on environmental education was examined at two related analytical levels. At the first level, descriptive bibliometric indicators were generated from the primary Scopus retrieval corpus (n = 428) to characterize the broader field. At the second level, the screened analytical subset (n = 50) was used for focused interpretative synthesis, particularly to examine how environmental education is defined, operationalized, and translated into curricular practice in higher education. The high-sensitivity complementary search was used only as retrieval support and did not form part of the core interpretative corpus.

The didactic strategy framework proposed in this study was derived from the convergence of three sources of analysis: bibliometric evidence on the structure and fragmentation of the field, focused synthesis of the screened analytical subset, and conceptual analysis developed through the broader structured literature review. Accordingly, the framework was not built from bibliometric frequency patterns alone. It emerged from the relation between mapped research trends, recurring curricular and pedagogical gaps in the literature, and the need to treat environmental education as explicit curricular content in higher education. This procedure allowed the framework to remain both empirically informed and educationally useful.

2.6. Bibliometric Analysis and Network Visualization

Bibliometric analysis was used to describe annual scientific output, leading countries, institutions, authors, source titles, document types, and subject areas within the Scopus datasets. Network mapping was carried out in VOSviewer to visualize relationships through co-authorship, keyword co-occurrence, and co-citation analyses. Before visualization, a thesaurus-based cleaning procedure was applied to merge synonymous terms, standardize spelling variants, and remove generic or non-informative expressions.

The VOSviewer analyses used full counting and association strength normalization. Co-authorship networks were generated with a minimum threshold of 2 documents per author and 3 documents per country. Keyword co-occurrence analysis was based on author keywords with a minimum threshold of 5 occurrences per keyword. Co-citation analysis was conducted for cited authors using a minimum threshold of 20 citations per cited author and, where source co-citation was examined, 25 citations per source title. These parameters were established in advance

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to strengthen transparency and reproducibility. Interpretation of the resulting outputs was informed by contemporary competency-based and sustainability-oriented perspectives that emphasize the curricular and pedagogical operationalization of environmental education in higher education (Bianchi et al., 2022; Shutaleva, 2023; UNESCO, 2022).

2.7. Methodological Rationale

The combined design adopted in this study was intended to address a problem that cannot be captured adequately through bibliometric description alone. Bibliometric mapping made it possible to identify the size, structure, and fragmentation of the field, but the structured literature review and focused synthesis were necessary to interpret how environmental education is being treated as curricular content and why curricular operationalization remains limited in higher education. The methodological contribution of the study therefore lies in linking field-level bibliometric evidence with framework development oriented toward curricular and pedagogical implementation. This linkage was especially relevant in light of previous work that has emphasized the importance of evaluable instruments, explicit competency pathways, and structured pedagogical support for environmental education and education for sustainable development in higher education institutions (Luna-Krauletz et al., 2021; Wang et al., 2022).

3. RESULTS

The results are presented at two complementary analytical levels. The first level reports descriptive bibliometric indicators for the primary environmental education retrieval corpus (n = 428). The second level offers a focused interpretative reading based on the screened analytical subset (n = 50) retained after eligibility assessment. In line with the methodological design, the high-sensitivity complementary search (n = 1,112) was used only as supplementary retrieval evidence and was not incorporated into the main analytical corpus.

3.1. Refined Didactic-Strategy Baseline Dataset

The refined Scopus query designed to capture the intersection among didactic strategy, environmental education/education for sustainable development, curricular content, and higher education retrieved 13 records for the period 2020–2026. Although the number is small, this corpus is methodologically useful because of its high specificity. What it shows is not simply low production volume, but a narrower problem in the indexed literature: the explicit combination of these four elements remains only weakly developed. Rather than indicating a consolidated research line, the dataset points to a limited and institutionally dispersed body of work with low thematic density. In practical terms, this means that, although didactic strategies are widely discussed in educational research, they are much less frequently linked in explicit ways to environmental education as curricular content in higher education. This finding supports the main idea of my study. In universities, environmental education is often just a broad aspiration. In fact, it is not yet an explicit or sequenced curricular category.

3.2. Primary Environmental Education Retrieval Corpus

Taken together, the main Scopus search on this topic found 428 records between 2020 and 2026, defining the bibliometric profile through production by year, country, institution, authors, titles, and subject areas. After screening, a specific subset of 50 records remained for a focused interpretation of curricular content, showing a visible but moderate production with an average of 33 papers per year and a peak of 40 papers in 2024 Figure 2. Overall, this indicates an active but not yet fully consolidated field, where countries like Spain, Brazil, Colombia, Chile, and Mexico shape the scholarship (Figure 3). At the institutional level, the University of Seville, the University of Chile, and the University of Barcelona emerged as the most productive (Figure 4), while authors such as Pérez Lienqueo, Prosser Bravo, and Calixto Flores led with three papers each (Figure 5), reflecting an active but decentralized structure without a dominant hub.

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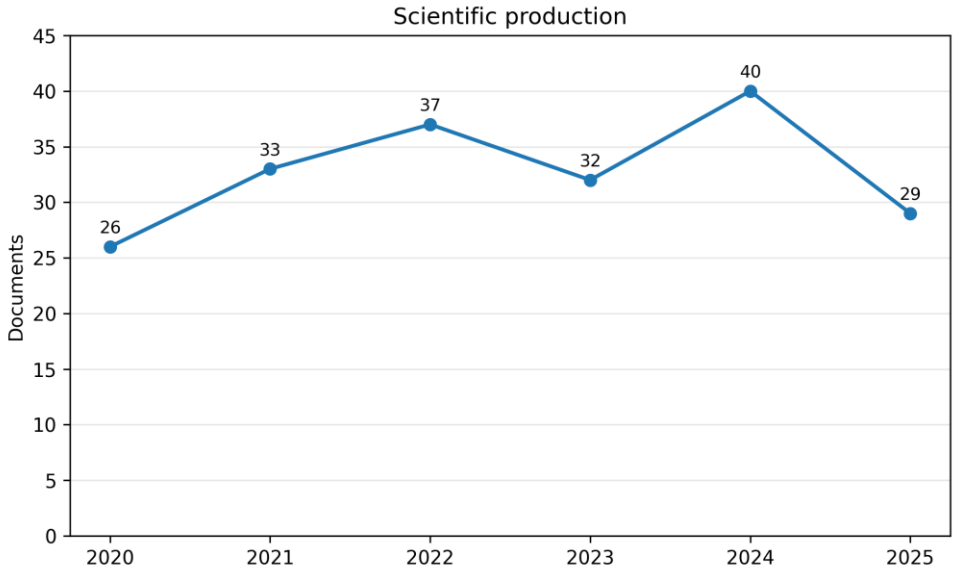

Figure 2. Annual scientific production on environmental education in higher education (2020–2025).

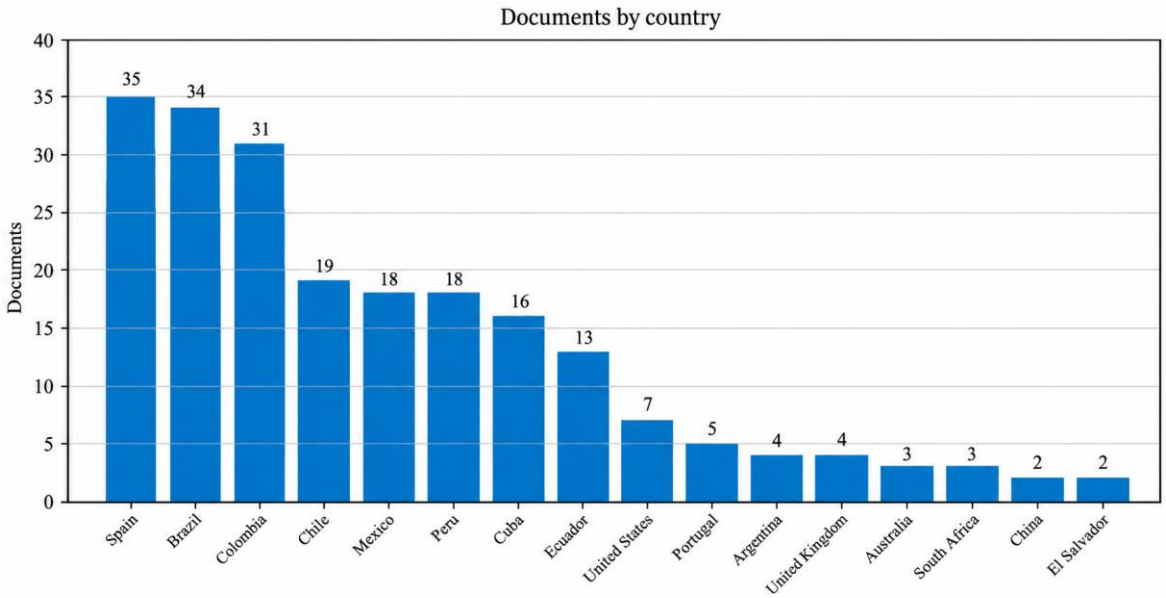

Figure 3. Scientific production by country in the primary Scopus retrieval corpus.

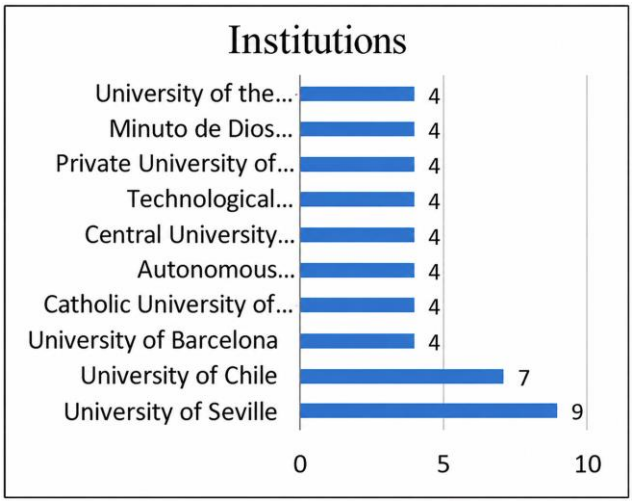

Figure 4. Most productive institutions in the primary Scopus retrieval corpus.

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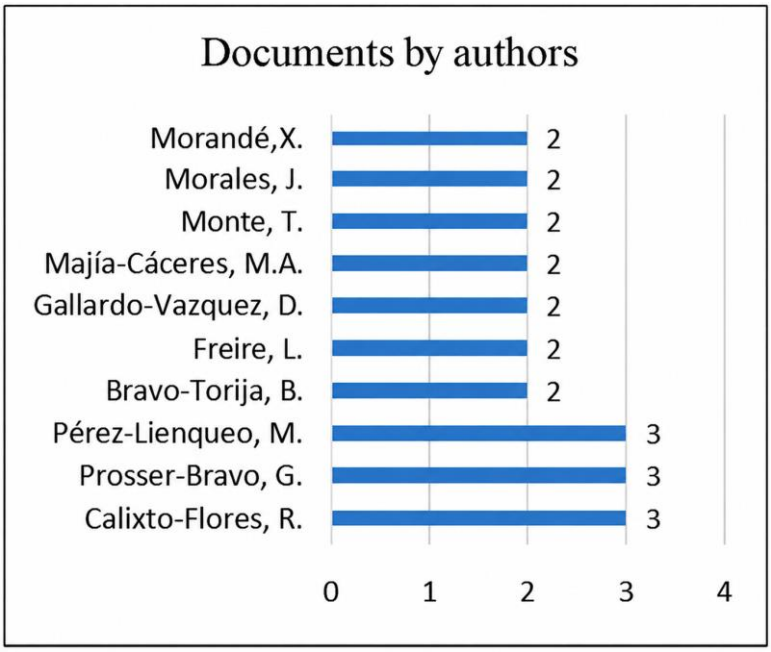

Figure 5. Most productive authors in the primary Scopus retrieval corpus.

Regarding the findings, the source titles with the highest visibility were Medio Ambiente y Sociedad, Universidad y Sociedad, and Revista Luna Azul (Figure 6), where journal articles represent the primary category (n = 179), followed by a lower frequency of reviews (Figure 7). Specifically, the most frequent subject areas include Social Sciences and Environmental Sciences (Figure 8), placing the field at the direct intersection of education and environment. Overall, these indicators suggest that environmental education has achieved a formal academic status, although the evidence also shows a fragmented field spread across different countries and journals. While the discipline is interdisciplinary, it still lacks a cohesive framework, showing a noticeable gap in research centered on curricular design, sequencing, and assessment.

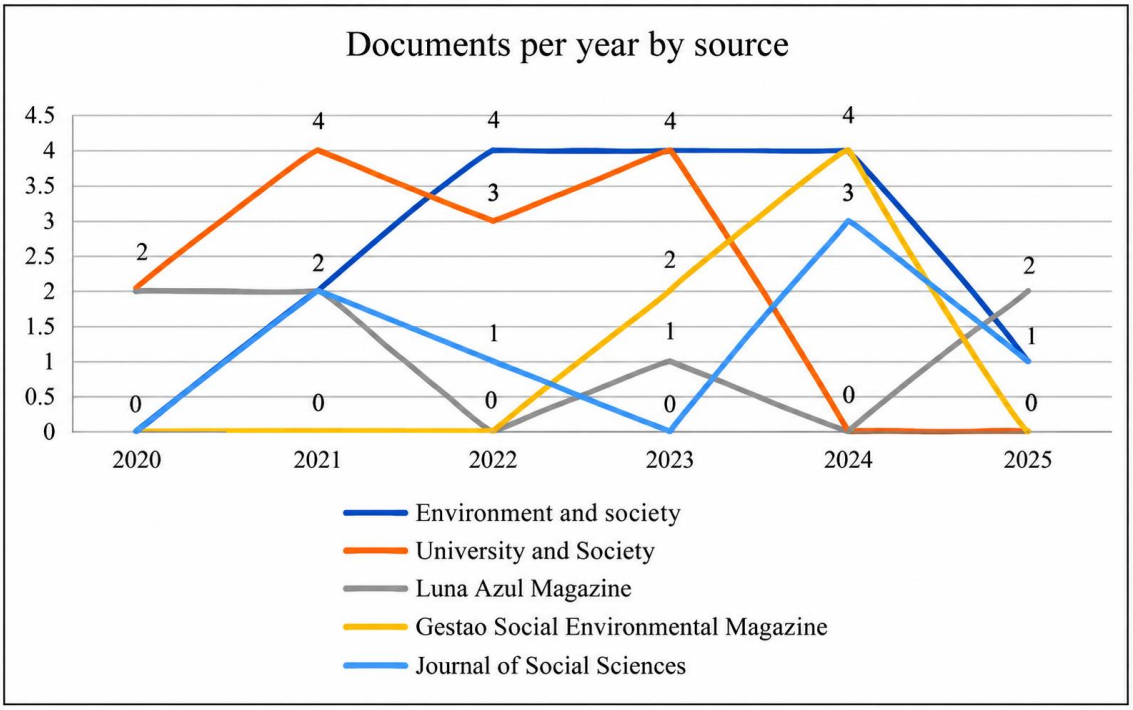

Figure 6. Documents per year by leading source titles in the primary Scopus retrieval corpus.

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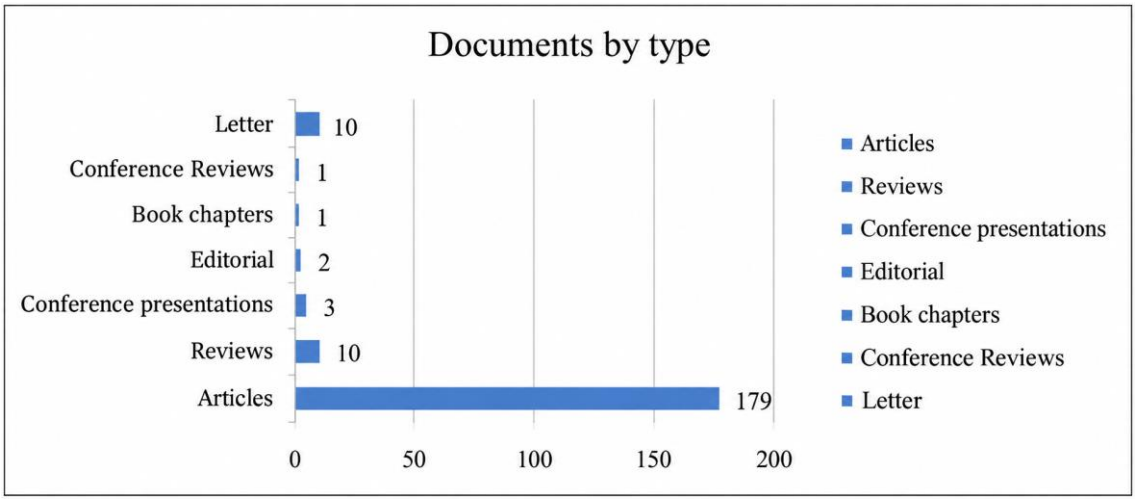

Figure 7. Distribution of document types in the primary Scopus retrieval corpus.

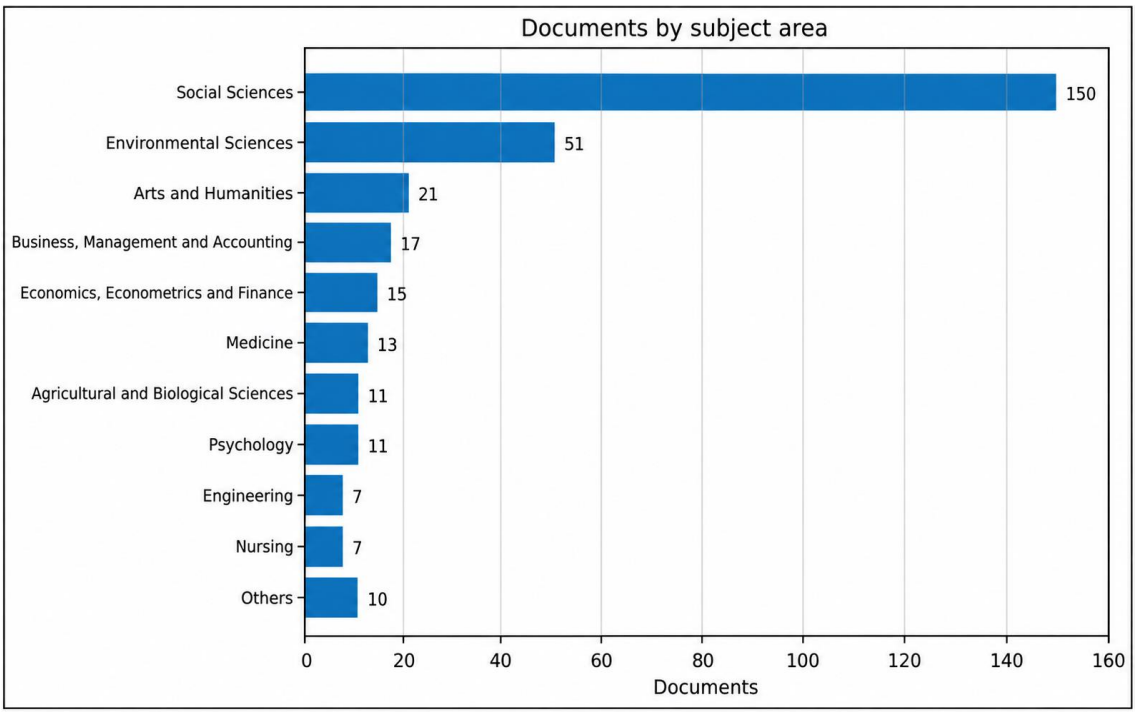

Figure 8. Subject-area distribution of documents in the primary Scopus retrieval corpus.

3.3. Network Visualization

Furthermore, a network analysis in VOSviewer examined relational patterns within the Scopus dataset, resulting in a map that showed a limited but identifiable citation core (Figure 9). In this network, three authors displayed the strongest mutual citation links, suggesting that the field has recognizable reference points, although the overall citation structure remains relatively narrow and not yet broadly interconnected. In fact, these results reinforce the same general interpretation seen in the descriptive indicators, confirming the current state of the discipline. Environmental education in higher education shows visible scholarly activity, but still has limited consolidation around shared conceptual and methodological anchors. In other words, the field appears to be evolving through multiple regional and disciplinary strands rather than through a stable and highly integrated international research network.

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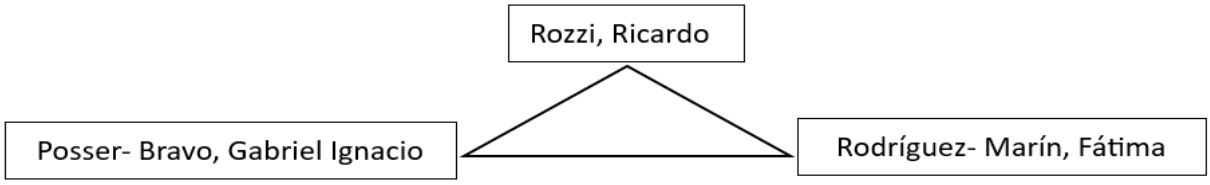

Figure 9. Co-citation network of leading cited authors in the Scopus dataset.

Note: Unless otherwise indicated, descriptive bibliometric figures for the EE dataset are based on the primary Scopus retrieval corpus (n = 428), whereas the focused interpretative discussion is informed by the screened analytical subset (n = 50).

3.4. Focused Interpretative Findings from the Screened Analytical Subset

The screened analytical subset (n = 50) offers more direct evidence on how environmental education is treated as explicit curricular content in higher education. Across this subset, three patterns appeared consistently. First, studies that explicitly connect environmental education, curricular content, didactic strategy, and higher education remain comparatively scarce. This is consistent with the small size of the refined baseline dataset and suggests that, even where environmental education is present in higher education research, it is less often approached in terms of how it should be structured, sequenced, and operationalized within curricula.

Second, the literature puts more emphasis on broad curricular integration. Regarding the findings, there is a lot of general discourse about sustainability, but there are fewer concrete operational models; furthermore, many studies support adding environmental education in universities, yet they do not offer clear guidance on course content or assessment practice. In addition, the screened subset points to ongoing weaknesses in faculty preparation and methodological planning, where evaluation mechanisms also show gaps; actually, this suggests that environmental education is still vulnerable, as the curricular treatment often depends on isolated teacher initiatives instead of coordinated institutional structures.

3.5. Synthesis of the Results

In summary, these results show a field with conceptual relevance and regional visibility, although environmental education as teachable content is still underdeveloped; consequently, the refined dataset shows that the literature is narrow at the intersection of didactic strategy and higher education. By contrast, the broader corpus confirms that research is active, but it remains fragmented and not fully consolidated; therefore, the main challenge is how to make environmental education systematic, sequenced, and institutionally sustainable. In that sense, the evidence provides the basis for the framework in this study, clarifying both the growth of the field and the continuing lack of operational models for its implementation.

4. DISCUSSION

In this context, the results suggest that the main limitation in this area is no longer whether environmental education is acknowledged in higher education; rather, the issue is whether it becomes curricular content that can be taught, sequenced, and assessed. The refined baseline dataset is useful here; it includes only 13 records at the intersection of didactic strategy, curricular content, environmental education, and higher education. This shows that the indexed literature is still narrow and not yet consolidated. This pattern is consistent with studies showing that sustainability has gained legitimacy in higher education; however, its conversion into operational curricular practice remains uneven and incomplete (Bianchi et al., 2022; Lozano et al., 2015; UNESCO, 2022). In other words, the field is visible at the conceptual level, but still weak at the level of implementation.

Likewise, another implication is the distance between institutional sustainability discourse and classroom-level enactment. Environmental themes may appear in policy documents, mission statements, or general curricular orientations; however, they are less consistently translated into explicit course content. They also appear less often as defined learning outcomes, pedagogical sequences, and assessment criteria. This is especially important in competency-based higher education because formal curriculum design does not automatically guarantee didactic

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operationalization within disciplines, subjects, and learning activities (Domínguez et al., 2024; Lambrechts et al., 2013; Navas-Ríos & Ospina-Mejía, 2020; Rosales, 2021). For that reason, the findings reinforce a stronger interpretation of curricularization. Environmental education must move beyond symbolic inclusion and become a teachable, assessable, and institutionally sustained part of university learning.

In this sense, this interpretation also helps clarify the limits of competency discourse. Sustainability competencies are now well established in higher education research, and there is broad agreement on the relevance of systems thinking, anticipatory competence, normative judgment, strategic action, and interpersonal competence (Annelin & Boström, 2023; Brundiers et al., 2021; Wiek et al., 2011). Even so, competency frameworks do not solve the curricular problem by themselves. They identify what students should develop, but they do not always explain how universities should organize content, pedagogical routes, and evaluation processes. This is necessary if these competencies are to be built progressively across programs. The present findings suggest that this remains one of the least developed areas in the literature. Environmental education is widely recognized as important; however, it is still less often treated as a clearly operationalized curricular category.

Moreover, the pedagogical implications of this gap are substantial. If environmental education is to function as curricular content, it needs instructional designs that connect content definition with method, context, and evaluation. Research on sustainability-oriented higher education has shown that problem-based learning, real-world engagement, and interdisciplinary pedagogies are useful, especially when they help students connect abstract environmental knowledge with situated professional and social action (Brundiers & Wiek, 2013; Rey-Garcia & Mato-Santiso, 2020; Wang et al., 2022). At the same time, didactic research has emphasized that the educational value of content depends on how it is selected, organized, mediated, and assessed, and also on whether this occurs within meaningful learning environments (Álvarez de Zayas, 1999; Arboleda, 2021; Herrera & Villafuerte, 2023). From this perspective, the problem is not only that environmental content may be insufficiently present. The problem is also that the pedagogical structures needed to sustain it across courses and disciplines are often weak or absent.

Additionally, another relevant finding is that curricular implementation depends not only on formal curricular design; it also depends on interpretative and institutional conditions. Research on environmental representations suggests that the meanings students and teachers assign to environmental issues shape how these issues are understood and enacted in academic settings (Arias Ortega, 2025; Calixto, 2025). This helps explain why curricular reform may remain uneven, even when institutional commitments already exist. It also shows that faculty development is broader than technical training. Teaching attitudes, participation conditions, and institutional climate affect whether curricular change becomes sustainable over time (Mayorga, 2024). Thus, the curricularization of environmental education depends on conceptual clarity and pedagogical design, but also on institutional coordination, professional engagement, and conditions that support socially responsive educational practice (Mayorga & Flores, 2025).

4.1. Implications for the Didactic Strategy Framework

In this regard, the didactic strategy framework proposed in this study responds directly to the weaknesses identified in the bibliometric and interpretative analyses. Its value does not lie in simply repeating that environmental education should be integrated into higher education, since that point is already well established in the literature. What the framework adds is an operational structure for doing so. By connecting theorization, methodological planning, faculty training, research, and monitoring and evaluation, it translates a broad sustainability commitment into a more concrete sequence of curricular and institutional actions. At this point, the study moves from diagnosis to response.

Likewise, the framework contributes to the literature in at least two ways. First, it treats environmental education not as a diffuse transversal principle, but as a curricular category that requires explicit definition, sequencing, instructional alignment, and assessment. Second, it recognizes that curricular change in higher education depends

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not only on content design but also on institutional conditions that make implementation durable over time. These conditions include faculty preparation, interdisciplinary articulation, and evaluative follow-up. This interpretation is consistent with previous work showing that sustainability-related curricular change requires competency-oriented design and structures capable of sustaining implementation across institutional settings (Busquets et al., 2021; Cebrián et al., 2020; Luna-Krauletz et al., 2021; Veidemane, 2022).

Finally, these findings suggest that the central challenge for higher education is not whether environmental education should be present. Rather, the challenge is how it can be curricularized in ways that are explicit, coherent, and assessable. The contribution of the present study lies precisely there. It shows that the field remains fragmented at the point where curricular content, didactic strategy, and higher education intersect, and it offers a framework designed to reduce that fragmentation. In that sense, the study advances from bibliometric diagnosis toward curricular-operational response, which is the shift required if sustainability discourse is to become a more stable educational practice.

4.2. Proposed Didactic Strategy Framework

In this context, the study proposes an integrated didactic strategy framework; its purpose is to strengthen the treatment of environmental education as explicit curricular content in higher education. The contribution is not only to recommend its inclusion in university curricula; rather, it seeks to organize that inclusion into an operational model. In this way, the framework can guide implementation across courses and programs; also, it moves beyond general advocacy and offers a more structured curricular response to the weaknesses identified through the bibliometric analysis.

Likewise, the framework was derived from three analytical sources developed in the study. First, it considered bibliometric evidence on the visibility and fragmentation of the field; second, it used the focused interpretative synthesis of the screened literature; and third, it incorporated the conceptual analysis of environmental education as curricular content in higher education. This process is important because the framework is not based only on recommendations. Rather, it is grounded in recurring patterns identified in the literature; in particular, it responds to the limited availability of operational models for sequencing, implementing, and assessing environmental education in university curricula.

In this sense, the framework is organized into five interconnected subsystems: theorization, methodological planning, faculty training, research, and monitoring and evaluation (Table 2). Together, these subsystems show the institutional and pedagogical work required for implementation; they also help convert environmental education from a broad sustainability commitment into structured curricular content. From this perspective, environmental education is not treated as a diffuse transversal principle; it is understood as a didactic category. For that reason, it requires explicit definition, instructional alignment, sequencing, and assessment. This interpretation is consistent with studies showing that sustainability-oriented curricular change depends not only on competency-oriented design but also on institutional conditions, faculty preparation, pedagogical coherence, and evaluative follow-up (Bianchi et al., 2022; Busquets et al., 2021; Cebrián et al., 2020; UNESCO, 2022).

Moreover, the framework addresses one of the clearest problems identified in the results: the gap between institutional sustainability discourse and course-level curricular enactment. Previous studies show that environmental and sustainability agendas are increasingly visible in higher education; however, they often remain insufficiently translated into teachable content, learning outcomes, and measurable implementation mechanisms (Lambrechts et al., 2013; Luna-Krauletz et al., 2021; Wang et al., 2022). By linking conceptual, methodological, formative, research-oriented, and evaluative dimensions, the framework offers a more explicit route for curricularizing environmental education; in this way, its implementation can become more systematic, assessable, and institutionally sustainable.

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A further strength of the framework is that it treats curricular implementation as both a pedagogical and an organizational process. In didactic terms, content requires coherence among objectives, methods, resources, forms of organization, and evaluation (Álvarez de Zayas, 1999; Arboleda, 2021; Herrera & Villafuerte, 2023). In institutional terms, however, that coherence cannot depend solely on individual teacher initiative. It requires structured planning, faculty support, interdisciplinary coordination, and monitoring routines that allow environmental education to be sustained over time. For that reason, the framework should be read less as a generic recommendation and more as an institutional implementation model for universities seeking to strengthen the curricular integration of environmental education in higher education. A more detailed operational version of the framework is presented in Supplementary Material S1.

Table 2. Proposed didactic strategy framework for curricularizing environmental education in higher education.

Subsystem	Specific objective	Core actions	Expected outputs/Evidence of implementation
Theorization	Consolidate the conceptual basis of environmental education as curricular content	Conduct a bibliometric and conceptual review of environmental education and curricular content; define the relationship between environmental education, sustainability competencies, and higher education curricula; produce a shared conceptual synthesis to guide institutional decisions	Shared institutional definitions; conceptual framework for EE-as-content; state-of-the-art synthesis to support curricular decision-making
Methodological planning	Translate environmental education into course-level curricular design and assessment	Review graduate profiles and course syllabi; identify EE-related objectives, content, and competencies; sequence content vertically and horizontally across the curriculum; establish interdisciplinary links; align content with methods, resources, learning activities, and assessment criteria	Sequenced EE content map; interdisciplinary articulation matrix; methodological guidelines for implementation; assessment criteria and rubrics
Faculty training	Strengthen faculty capacity for consistent curricular implementation	Diagnose faculty needs and strengths; design training activities, workshops, or diploma-level programs; provide mentoring and peer exchange spaces; promote reflective practice and collaborative planning	Faculty training plan; mentoring records; communities of practice; improved consistency in environmental education delivery across courses
Research	Generate institutional knowledge and innovation around EE-as-content	Promote research lines on environmental education and curricularization; develop applied projects and dissemination activities; support publication, collaboration, and evidence generation linked to implementation processes	Research projects; articles and theses; dissemination outputs; collaborative networks; increased institutional visibility in the field
Monitoring and evaluation	Assess implementation fidelity, outcomes, and opportunities for improvement	Monitor the incorporation of EE into curricula; evaluate fidelity of implementation, coherence of sequencing, and alignment with learning outcomes; use feedback to adjust content, methods, and assessment	Monitoring indicators; evaluation reports; iterative revisions of the framework; documented evidence of curricular integration over time

Note: The framework is conceived as an open, reflective, and adaptive system that can be scaled according to institutional capacity and contextual conditions. Its purpose is not to impose a fixed curricular model, but to support progressive and evidence-informed implementation of environmental education as explicit curricular content in higher education.

5. CONCLUSIONS

To start, the process must begin from the fact that environmental education needs treatment as an explicit curricular process, and not from an aspirational point of view; indeed, this is an enriching contribution, because when it is deliberately organized, taught, and assessed, it can contribute more directly to the development of sustainability competencies. Likewise, it helps in training graduates with the skills to: a) critically analyze socio-environmental

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challenges; b) make responsible decisions regarding those challenges; and c) act ethically and contextually in different scenarios (Bianchi et al., 2022; Wiek et al., 2011).

In the same way, the results show that environmental education has gained visibility in higher education research; however, its treatment as explicit curricular content remains limited in the indexed literature. Furthermore, according to Luna-Krauletz et al. (2021) and Lozano et al. (2015), this situation occurs when environmental education appears more as a transversal principle or institutional aspiration than as organized content within the curriculum. In contrast, from the didactic perspective proposed by Álvarez de Zayas (1999), content should be sequenced, implemented, and evaluated clearly within training programs; therefore, curricular integration remains uneven; also, the didactic meaning of content still requires further development, especially in aspects related to course planning, instructional design, and assessment.

To address this gap, the present study proposes an integrated didactic strategy framework; basically, this framework goes beyond general calls for curricular inclusion; moreover, it organizes the curricularization of environmental education into five subsystems: theorization, methodological planning, faculty training, research, and monitoring and evaluation. According to Arboleda (2021), Busquets et al. (2021), and UNESCO (2022), curricular integration requires conceptual clarity; it also needs pedagogical action and institutional support. In this sense, the proposed framework connects these elements, and it offers a way to reduce fragmentation between programs and courses.

From a practical perspective, the findings show that higher education institutions can advance better in sustainability; above all, when they do not treat environmental education only as a guiding principle. It must also be assumed as organized curricular content; for this, it requires instructional alignment, faculty development, and evaluative follow-up. Additionally, curricularization does not depend only on what universities wish to teach; it also depends on the institutional and pedagogical conditions that allow its implementation. For this reason, future research should test the framework through pilot experiences and also through longitudinal evaluations. In particular, it is useful to analyze implementation fidelity, learning outcomes, and program effects on sustainability competencies. According to Annelin and Boström (2023), Veidemane (2022), and Wang et al. (2022), this type of study can help determine if the framework allows for measurable curricular transformations and if it strengthens the institutional capacity for environmental education in higher education.

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