



## GLOBAL RESEARCH TRENDS IN ENVIRONMENTAL EDUCATION AND ENVIRONMENTAL AWARENESS: A BIBLIOMETRIC ANALYSIS

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### ABSTRACT

Environmental education and awareness are recognized as strategic pillars of sustainable development for addressing the challenges posed by the global ecological crisis. However, scientific output has become fragmented, hindering the identification of emerging trends and research gaps. The objective of this study was to analyse the evolution of scientific output published between 1999 and 2024 using bibliometric analysis. The study followed the PRISMA guidelines to ensure transparency and reproducibility of results. Inclusion and exclusion criteria were applied, and a total of 820 documents were analyzed. VOSviewer and Biblioshiny were used to map the selected publications. The results showed that the annual growth rate of scientific output was 13.38%, evidence of the progressive consolidation of the field of research. Journals ranked in the first and second quartiles of Scopus stood out for the number of publications related to the study topic. China and the United Kingdom emerged as leaders in international collaboration and citation impact, evidence of the consolidation of global research networks. The thematic analysis indicates that the main pillars of the research focus on environmental education, pro-environmental behavior, and environmental awareness, which are consolidated through educational practices grounded in sustainability. It was concluded that, since 2012, researchers' interest in the topic has increased significantly, contributing to the systematization of scientific knowledge and identifying future lines of research, particularly on environmental awareness and its impact on early childhood education.

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### INTRODUCTION

The global ecological crisis is intensifying as climate change and environmental pollution worsen, creating a need to reform education systems to change citizens' attitudes. Environmental education and awareness, therefore, play a strategic role in promoting attitudes and values linked to environmental protection and sustainability. However, environmental practices have not been sustainable and are insufficient to support environmental education (Szczebankiewicz et al., 2021; Mondragon et al., 2023; Ma et al., 2023;

García-Muñoz et al., 2024; Hnatyuk et al., 2024; Mliless et al., 2024)

In the context of the global ecological crisis, characterized by climate change, environmental pollution, and biodiversity loss, environmental education and awareness have been increasingly recognized as strategic pillars of sustainable development. This challenge threatens ecological balance and economic stability, requiring comprehensive educational responses that promote responsible attitudes and behaviors toward the environment. Environmental education and awareness contribute not only to the acquisition of scientific knowledge but also to the internalization of values, attitudes, and ethical principles

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oriented toward environmental protection in educational settings (Al-Maliki et al., 2021; Liu et al., 2023; García-Muñio et al., 2024; Hnatyuk et al., 2024; Imran et al., 2024)

Through this integrated approach, education becomes a transformative tool that shapes citizens who are aware of their environmental responsibilities and committed to sustainable practices. It also provides an opportunity for self-assessment and to identify changes that need to be implemented on a personal and professional level. Society needs leaders and the identification of shared goals.

Within this framework, the 2030 Agenda for Sustainable Development also highlights the importance of education as a key driver for achieving sustainability goals and recognizes that environmental awareness is fundamental for promoting active citizen participation at all educational levels, from early childhood education to higher education (Tadena & Salic-Hairulla, 2021; Mliless et al., 2024)

This perspective is characterized by the view that environmental education is a necessity that must be implemented in curricula, thereby contributing to the consolidation of critical thinking and civic participation so that citizens can make responsible decisions in their daily lives, prioritizing environmental protection (Hernawan et al., 2021; Szczepankiewicz et al., 2021; Cotler et al., 2022; Mondragon et al., 2023)

Environmental education can be defined as a comprehensive pedagogical process aimed at developing knowledge, skills, and competencies that enable citizens to act responsibly in addressing environmental problems. Environmental awareness, in turn, manifests itself through concrete actions and attitudes that guide pro-environmental behavior in everyday contexts and materialize in actions aimed at resource conservation, waste management, and sustainable consumption practices (Meschini et al., 2021; Wang et al., 2021; Ma et al., 2023; Tobar et al., 2023; Wu et al., 2023; Liu & Tobias, 2024) While these concepts are related, it is important to recognize that greater environmental knowledge does not guarantee the adoption of pro-environmental behavior. In this regard, studies have shown that people do not always translate acquired knowledge into concrete actions. This situation highlights the need to examine environmental education and environmental awareness from a comprehensive perspective applicable to different educational levels (Minelgaité & Liobikienė, 2021; Scorrano & Rotaris, 2022; Yang et al., 2022; Nahar et al., 2023; Juma-Michilena et al., 2023; Uddin, 2024)

A preliminary review of the scientific literature reveals research on environmental education and environmental awareness, suggesting that these can be strengthened through the promotion of pro-environmental behavior at different educational levels. Some studies were based on planned behavior theory, others on the role of the teacher, and others on a set of pedagogical strategies implemented in concrete actions (Orbanić & Kovač, 2021; Sprague et al., 2021; Iwasaki, 2022; Lin et al., 2022; Biber et al., 2023).

In response to this identified gap, the present study aims to analyze scientific output on environmental education and environmental awareness in order to identify research patterns linked to the sources and authors who published most frequently, thereby systematizing the topic and providing a basis for future research (Debrah et al., 2021; Finger et al., 2021; Al-Nuaimi & Al-Ghamdi, 2022; Chen et al., 2022; Khalifé et al., 2022; Yang et al., 2022).

Several studies have identified uneven development in educational systems regarding the implementation of environmental education. Some authors note that cognitive learning approaches predominate, neglecting affective and experiential components, thereby hindering the promotion of environmental engagement. This absence represents an obstacle that extends beyond implementation at all educational levels, limiting the effectiveness of environmental education and diminishing its importance. Furthermore, educational policies often lack coherence and consistency, and are not uniform in their design and implementation (Orbanić & Kovač, 2021; Thapa, 2021; Lovren & Jablanovic, 2023; Tobar et al., 2023). Therefore, given this identified gap, comprehensive educational frameworks are needed to promote values formation and a transformation in everyday behavior (Robina-Ramírez et al., 2020; Echegoyen-Sanz & Martín-Ezpeleta, 2021; Niu et al., 2022; Uddin, 2024).

With the implementation of the 2030 Agenda and the Sustainable Development Goals, scientific output on environmental education and environmental awareness has increased. Thus, education is seen as a cross-cutting issue that can address debates related to environmental problems. However, growth can be excessive or disorganized, making it difficult to identify established patterns, which is why there is a need for an integrated vision with a multidisciplinary approach (Al-Nuaimi & Al-Ghamdi, 2022; Chen et al., 2022; Yang et al., 2022; Tan & Nurul-Asna, 2023; Young & Malone, 2023). Similarly, studies have adopted the theory of planned behavior as a

conceptual framework for analyzing actions stemming from environmental awareness. This theory is based on the shaping of attitudes and the transformation of individual behavior in compliance with social norms, prioritizing the common good (Yusuf et al., 2021; Ferreira & Fernandes, 2022; Niu et al., 2022b; Liu & Tobias, 2024). In this sense, promoting positive attitudes lays the groundwork for strengthening sustainability. Developing habits contributes to addressing environmental challenges, and collective actions focus on overall well-being (Debrah et al., 2021; Lin et al., 2022; Oe et al., 2022; Huang & Hsin, 2023; Hnatyuk et al., 2024; Sihvonen et al., 2024).

In this context, analyzing the evolution of scientific production in education and environmental awareness is relevant because it reflects the topic's acceptance among researchers. Furthermore, it allows us to determine the dominant themes and the areas or topics requiring priority attention. Therefore, bibliometric analysis is a methodologically appropriate tool for mapping scientific output and identifying future lines of research (Al-Nuaimi & Al-Ghamdi, 2022; Begum et al., 2022; Chen et al., 2022; Wu et al., 2023).

Similarly, it is important to recognize that teachers play a leading and mediating role in implementing environmental education. As key agents in the learning process, they influence students' perceptions and behaviors. A positive attitude toward environmental issues fosters transformation and improves the learning process (Drosos et al., 2021; Orbanić & Kovač, 2021; Petkou et al., 2021; Huang & Hsin, 2023; Escobedo et al., 2024).

However, evidence indicates that teaching practices are not always consistent with the principles of environmental education. In some cases, inadequate training and institutional support limit teachers' ability to propose and lead environmental education in the classroom. Along these lines, there is a recognized need to strengthen teacher training programs, specifically regarding the consolidation of environmental education principles at all educational levels (Petkou et al., 2021; Dominguez Contreras & Krasny, 2022; Lovren & Jablanovic, 2023; Saifulina et al., 2023; García-Muñoz et al., 2024).

Furthermore, experiential learning has become one of the most prominent pedagogical strategies to overcome the limitations of traditional approaches. Experiential learning is based on the active participation and reflection that students must undertake in their pursuit of practical experience. Along the same lines, research has

been identified that promotes project-based activities, community participation, and direct contact with environmental issues to foster environmental awareness and generate a multiplier effect in society (Sprague et al., 2021; Lin et al., 2022; Miyasaka & Honda, 2024; Poje et al., 2024).

Complementarily, digital technologies represent an emerging line of research in environmental education, interconnected with student participation and motivation. In this context, digital tools and interactive learning resources are new alternatives for improving teaching. However, the use of digital technologies requires short- and long-term evaluation to verify the importance of motivation in achieving objectives and the students' predisposition towards environmental awareness (Küçükaydın & Ulum, 2023; Tan & Nurul-Asna, 2023; Rasyid et al., 2024).

The scientific literature shows growing interest in environmental education and awareness across different educational levels and contexts. This has led to the need to prioritize environmental education in educational policies that can be replicated in both the public and private sectors (Szczepankiewicz et al., 2021; Yang et al., 2022; Doddapanen et al., 2024; Uddin, 2024).

However, this evidence is scattered across time and subject matter, making it difficult to identify patterns in the research and gaps in the existing literature. Therefore, the proposal to conduct a bibliometric analysis is reinforced, as its characteristics make it a relevant methodological tool for mapping accumulated knowledge and guiding future researchers (Al-Nuaimi & Al-Ghamdi, 2022; Yang et al., 2022; Tan & Nurul-Asna, 2023; García-Muñoz et al., 2024).

As noted, there is still no comprehensive integration and evolution of scientific research on the subject under study. In the absence of comprehensive research, it is important to recognize the gap in educational policies and the lack of a strategy to strengthen environmental education for the benefit of the community (Littledyke, 2008; Debrah et al., 2021; Yang et al., 2022; Lovren & Jablanovic, 2023; Tan & Nurul-Asna, 2023; Uddin, 2024).

A preliminary review of the scientific literature shows that scientific output on environmental education and environmental awareness has grown significantly in recent decades, confirming its relevance in promoting environmentally friendly behavior and its inclusion as policy at different levels of the education system. However, existing studies are scattered, which does not allow for the identification of research patterns or

the consolidation of thematic axes (Al-Nuaimi & Al-Ghamdi, 2022; Chen et al., 2022; Yang et al., 2022). Furthermore, it is recognized that previous studies focused on the analysis of pedagogical strategies and did not identify the collaborative networks or thematic evolution of this field of research (Orbanić & Kovač, 2021; Thapa, 2021; Lovren & Jablanovic, 2023). In this regard, the scattered nature of the studies makes it difficult to identify future research, which is why there is a need for a bibliometric analysis that systematizes global scientific production.

The objective of this study is to perform a bibliometric analysis of the scientific production on environmental education and environmental awareness published in the Scopus database between 1999 and 2024 to examine its evolution over time, identify the main sources of information, collaboration networks, and emerging thematic trends that contribute to strengthening the theoretical and empirical foundations of the topic.

In this regard, the following research questions are posed:

RQ1. How did scientific output on environmental education and environmental awareness evolve between 1999 and 2024?

RQ2. Which authors, institutions, and countries were most influential in the selected scientific output?

RQ3. What collaborative networks exist between authors, institutions, and countries in research on environmental education and environmental awareness?

RQ4. What are the main thematic clusters that make up the structure of environmental education and environmental awareness?

## METHODS

This study used a bibliometric research design and a descriptive-analytical scope. Its objective was to analyze the evolution of scientific production on environmental education and environmental awareness to identify research trends (Donthu et al., 2021).

### Research Stages

#### Stage 1: Identification of sources and search strategy

The Scopus database was selected, which is characterized by bringing together high-impact journals with multidisciplinary coverage (Mongeon & Paul-Hus, 2016). The search was conducted

on December 9, 2025, and included the fields title, abstract, and keywords (TITLE-ABS-KEY). Boolean operators were used, and the search strategy was proposed:

TITLE-ABS-KEY (“environmental education” OR “education for sustainability” OR “environmental literacy”) AND (“environmental awareness” OR “environmental consciousness”) AND (education OR learning OR teaching OR “science education” OR “environmental science education”).

#### Stage 2: Selection and eligibility of documents

The PRISMA guidelines were used to select documents, thereby ensuring the transparency and reproducibility of this study.

The inclusion criteria were: publications from 1999-2024, documents in the final phase, and those related to environmental education and environmental awareness. The exclusion criteria were: duplicate records and documents not within the study’s scope.

Applying the above criteria reduced the initial set of 1,206 documents to 820 documents.

#### Stage 3: Data extraction and preparation

Bibliographic metadata were exported from Scopus in CSV format. The variables extracted included citation, bibliographic, and author information.

#### Stage 4: Bibliometric data analysis

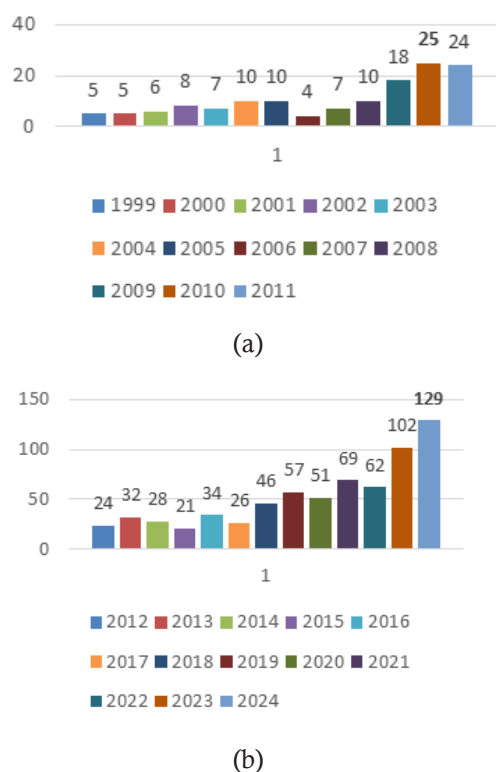
The bibliometric analysis was performed using the Biblioshiny interface of the Bibliometrix package (version R 4.4.1) (Mondal, 2025).

#### Stage 5: Thematic mapping and visualization

VOSviewer software (version 1.6.18) was used to construct co-occurrence networks of authors’ keywords.

## RESULTS AND DISCUSSION

The preliminary results of this study showed remarkable growth and progressive consolidation in scientific production on environmental education and environmental awareness. It also revealed a dispersed structure, indicating limitations in academic integration. In this context, there is a need for a bibliometric analysis to identify research patterns, which is the main contribution of this study.



**Figure 1.** Annual Scientific Output: (a) 1999-2011, (b) 2012-2024

The temporal evolution illustrated in Figures 1a and 1b demonstrates the consolidation of scientific production on environmental education and environmental awareness. A period of consolidation can be seen beginning in 2012, coinciding with international interest in protecting the environment and integrating sustainability actions into environmental education. In this way, environmental education becomes a cross-cutting theme that can be strengthened at different educational levels.

In this regard, the findings described address the analytical gap identified in the fragmentation of the scientific literature. This study systematized 25 years of scientific output, demonstrating when global interest among researchers began, how it evolved, and the importance of international collaboration.

Since 2012, the scientific community has shown a marked interest in investigating the implementation of the Sustainable Development Goals in the educational field. This demonstrates that environmental education is an outstanding task that requires the participation and acceptance of authorities, teachers, students, and parents. Environmental commitment must be part of a change, one that begins with self-evaluation, the responsible use of resources, and a greater understanding of everyday practices to avoid actions that harm the environment. International col-

laboration is one way to promote research, and institutions have a responsibility to incentivize their researchers to establish a replicable precedent (Yang et al., 2022; Mondragon et al., 2023; Hnatyuk et al., 2024; Uddin, 2024).

**Table 1.** Most Relevant Sources

Sources	H-index	Documents
Sustainability (Switzerland)	207	47
Environmental Education Research	98	24
E3S Web of Conferences	45	19
IOP Conference Series: Earth and Environmental Science	58	15
Journal of Cleaner Production	354	15
BIO Web of Conferences	18	12
Australian Journal of Environmental Education	29	10
Eurasia Journal of Mathematics, Science and Technology Education	63	10
International Research in Geographical and Environmental Education	40	10
Journal of Environmental Protection and Ecology	28	9

Table 1 shows the sources that stood out for the number of publications produced. Many sources adopt a multidisciplinary approach and correspond to the g-quartiles 1 and 2 in Scopus. This situation demonstrates that a high level of importance has been achieved in the scientific community and that there is interest in environmental sustainability.

It is important to recognize that the diverse range of topics contributes to the consolidation of the educational process in environmental education, becoming a mechanism for transforming behavior through specific related practices such as recycling, waste management and the responsible use of resources (Minelgaitė & Liobikienė, 2021; Yang et al., 2022; Doddapanen et al., 2024; Liu & Tobias, 2024).

Tables 2 and 3 complement the literature on the subject under study. Table 2 shows the authors who contributed their research, and Table 3 shows the involvement of institutions in promoting lines of research related to environ-

mental education and environmental awareness. It should be noted that there is geographical diversity, meaning no concentration in a particular territory; rather, it reflects global interest in collaborating on the subject of study across different disciplines (Mondragon et al., 2023; Hnatyuk et al., 2024; Uddin, 2024).

In this regard, scientific research on environmental education and environmental awareness is decentralized and of global interest. This suggests that the subject has matured in recent years and that there is agreement on its application in educational contexts. Likewise, it can be seen that the distribution of scientific output

suggests growing involvement by researchers, a situation that will become an emerging specialization, promoting collaboration between institutions from different parts of the country to strengthen interregional cooperation (Al-Nuaimi & Al-Ghamdi, 2022; Chen et al., 2022; ondragon et al., 2023; Liu et al., 2023 García-Muñoz et al., 2024).

It is necessary to identify the most productive authors to understand the scientific structure of the field of research. In this way, leadership consolidation will be visualized through the number of documents published and the impact of citations derived from scientific production.

**Table 2.** Most Relevant Authors

Author	Affiliation	H-index	Documents
Gündüz, Şerife	Yakın Doğu Üniversitesi (Cyprus)	5	5
Skanavis, Constantina	National School of Public Health (Greece)	13	5
Mliless, Mohamed	Université Moulay Ismaïl (Morocco)	1	4
Abdul-Wahab, Sabah Ahmed	Sultan Qaboos University (Oman)	34	3
Agulló Torres, Asunción Maria	Universidad Miguel Hernández de Elche (Spain)	4	3
Aminrad, Z.	Universiti Kebangsaan Malaysia (Malaysia)	4	3
Aslanova, Fidan	Yakın Doğu Üniversitesi (Cyprus)	4	3
Del Campo-Gomis, Francisco José	Universidad Miguel Hernández de Elche (Spain)	8	3
Indriyani, Vivi	Universitas Negeri Padang (Indonesia)	5	3
Kopnina, Helen	University of Northumbria (United Kingdom)	37	3

Table 2 shows that scientific output is concentrated among a group of authors from various geographical regions, reflecting international interest in the field and participation in collaborative networks supported by institutions.

It is also important to analyze the institutions that stand out for their contributions to the development of research on environmental education and environmental awareness.

**Table 3.** Most Relevant Affiliations

Affiliation	Documents
University of Thessaly	9
Faculty of Education	7
Universidade de Aveiro	7
Alma Mater Studiorum Università di Bologna	6
Financial University Under the Government of The Russian Federation	6
Not Reported	6
Griffith University	5
National Sun Yat-Sen University	5
The University of Hong Kong	5
Universidad del País Vasco	5

Table 3 shows that institutions from different countries share a common concern and interest in the subject under study. This list of in-

stitutions underscores the importance of ongoing research to recognize the global expansion of scientific production.



**Figure 2.** Most Cited Countries

Figure 2 shows the impact of citations, demonstrating that China and the United Kingdom are leaders in this field. This highlights the importance of international collaboration and global interest in strengthening environmental education policies, which is beneficial to society.

It should be noted that, based on the number of citations, international collaboration is recognized as being in the process of consolidation, a situation that will give rise to alternatives in the design of educational policies aimed at environ-

mental protection and sustainability (Szczepankiewicz et al., 2021; Cotler et al., 2022; Niu et al., 2022a).

In this regard, countries with a shared intent to examine educational policies and their relationship with sustainable development may join forces with China and the United Kingdom, thereby consolidating the concept of science education for the benefit of the international community.

**Table 4.** Most Global Cited Documents

Title	TC
Greening due to environmental education? Environmental knowledge, attitudes, consumer behavior and everyday pro-environmental activities of Hungarian high school and university students	716
Sustaining the environment through recycling: An empirical study	367
Raising awareness on solid waste management through formal education for sustainability: A developing countries evidence review	326
The future of cool temperate bogs	219
Survey and analysis of consumers' behavior of waste mobile phone recycling in China	216
Science education for environmental awareness: approaches to integrating cognitive and affective domains	216
Public awareness and willingness to pay for tackling smog pollution in China: A case study	196
Effect of environmental awareness on purchase intention and satisfaction pertaining to electric vehicles in Japan	173
Local people value the environmental services provided by forested parks	148
Relationship between awareness, knowledge, and attitudes towards environmental education among secondary school students in Malaysia	131

TC: Total Citations

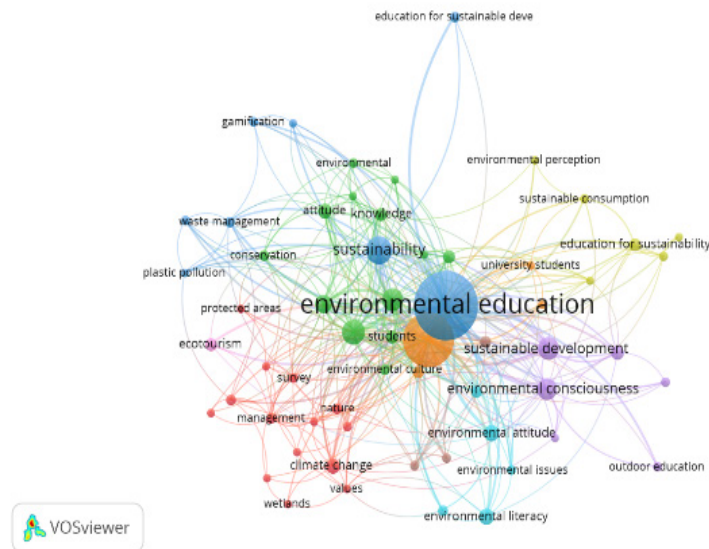
Table 4 shows the most cited documents on environmental education and environmental awareness. The authors highlight the importance of developing a theoretical framework related to pro-environmental attitudes and behaviors.

The results on the most cited documents express the relevance of environmental education practice in strengthening environmental behavior.

Likewise, it can be seen that the second most cited document is entitled 'Sustaining the

environment through recycling: An empirical study', which was co-authored and demonstrates that environmental awareness influences the behavior of university students, who through recycling reinforce the fundamental role of environmental education (Kurupparachchi et al., 2021; Shri & Tiwari, 2021; Wu et al., 2023).

In this vein, the trend in the identified documents is to explain the importance of pro-environmental behavior in the student training process, which is a central focus of environmental education and a direct way to enhance the multiplier effect of everyday practices.



**Figure 3.** Co-occurrence Network

Figure 3 shows the co-occurrence network of author keywords, highlighting environmental education as the central term, which is located transversally and integrates the terms students, sustainability, and environmental culture.

Likewise, the coexistence of terms related to environmental management and educational experiences can be seen, confirming that the researchers' initial interest was cognitive and shifted towards affective and behavioral dimensions. In this vein, the different clusters show that it is indeed possible to interrelate topics such as environmental management and educational practices (Minelgaitė & Liobikienė, 2021; Lovren & Jablanovic, 2023; Hnatyuk et al., 2024).

Thus, the novelty of this study lies in the analysis of temporal evolution and the identification of a regulatory framework useful for bringing about societal change. Environmental education must continue to be the connecting thread for concrete actions starting in early childhood education.

This result is consistent with previous research that emphasized the practical experiences of formal education as a basis for promoting changes in pro-environmental behavior for everyday life (Debrah et al., 2021; Sprague et al., 2021; Poje et al., 2024).

Along the same lines, the results provided a comprehensive overview of the subject under study, which will enable the consolidation of the theoretical

foundations for future research and encourage international collaboration through educational policy-making and its contribution to sustainable development goals.

It should be noted that the results are robust because they are derived from high-quality sources that rank in the top quartiles of Scopus. Thus, this study confirms its scientific credibility and recognizes environmental education as a topic of interest to the international academic community.

In this vein, the results represent a contribution and response to global challenges of sustainability and environmental protection.

## CONCLUSION

This study conducted an exhaustive bibliometric analysis of scientific output on environmental education and environmental awareness published between 1999 and 2024, highlighting the progressive consolidation and sustained growth of this field of research. The findings show an evolution towards educational practices that are oriented towards sustainability and pro-environmental behaviors embedded in education systems. From a conceptual perspective, this study contributes to the systematization of scientific knowledge by identifying its thematic evolution,

scientific leadership, and patterns of international collaboration. The main impact of this research is to provide guidance for future research and to recognize that educational policies are being consolidated to support environmental protection in line with the Sustainable Development Goals.

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