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Environmental Education: A Strategy for Nature Preservation

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Abstract

Environmental education is an essential strategy for nature conservation. To this end, an analysis is needed to explore its impact from the perspective of scientific literature. This study was conducted using a bibliometric approach based on the analysis of articles published between 2019 and 2023 in the Scopus, Web of Science, and Google Scholar databases. The terms "environmental education" and "nature preservation" were analyzed. Indicators associated with the number of publications, collaboration networks, main trends, and keyword co-occurrence, among others, were taken into account. The VOSviewer software, the platform lens.org, and the bibliographic manager Zotero were used. Different authors addressing the topic, the institutions with the highest output, the fundamental keywords, and the interrelationship between the categories of conservation, sustainability, and critical pedagogy were identified. Among the most cited articles are those with community-based and participatory approaches. The analysis shows an increase in research on environmental education, although there are some longitudinal and comparative gaps between different regions. It concludes by stating that this field is moving towards interdisciplinary methodologies and has a high social component.

Keywords: *Conservation, Environmental Education, Nature, Preservation, Sustainability.*

Introduction

The link between humanity and nature currently faces substantial challenges. Ecosystems are degrading, biodiversity loss is increasing, and climate change requires urgent and unified intervention (Calapez et al., 2023). In this context, environmental education is a tool for increasing values and awareness and encouraging actions that can promote environmental preservation.

In recent years, environmental education has evolved from informative approaches to more critical and participatory ones. Its objective goes beyond the transmission of knowledge. It is based on promoting behavioral changes and strengthening social commitment to sustainability (Sanabria Martínez, 2022). It is necessary to determine how these issues are addressed in current academic production and to identify gaps, trends, and opportunities for their promotion. This article considers the role of environmental education as a strategy for nature preservation (Gong et al., 2021).

A bibliometric analysis of studies published between 2019 and 2023 was carried out. The aim is to provide an overview of advances in this field and highlight the most relevant contributions and areas requiring attention (Costadone & Vierikko, 2023). The results seek to guide future research and educational practices that take into account a significant impact on environmental conservation (González Vallejo, 2023). The crisis facing the world from an environmental point of view is one of the greatest challenges for the sustainable development of humanity.

Some phenomena associated with deforestation, global warming, ocean pollution, and others affect ecosystems and the quality of life of present and future generations. Given this, education must position itself as a transformative tool that can generate long-term solutions (Cavalcanti et al., 2023). Various international institutions and organizations recognize that nature conservation requires not only public policies and technological advances, but also a profound change in the way people relate to their environment (Mansur et al., 2022).

That is why this cultural change can be achieved through educational processes that promote a more comprehensive understanding of environmental problems and possible solutions (Panizzut et al., 2021).

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Education proves its effectiveness once it transcends the classroom and connects with communities and territories to develop specific actions (Karantoni et al., 2023). Different local experiences show how educational projects that involve citizens have a greater impact on natural resource conservation than regulatory strategies or prohibitive actions.

An interdisciplinary approach is an essential aspect of environmental education (Gordon, 2019). This cannot be addressed solely from the perspective of biology or ecology; it is necessary to incorporate other elements such as economics, sociology, environmental ethics, anthropology, ethnography, and others (Nemutamvuni et al., 2020). This integration allows ecological problems to be studied and analyzed from multiple perspectives, in addition to recognizing their complexity and social dimensions.

In the last five years, various pedagogical innovations have focused on methodologies such as project-based learning, the use of digital technologies, and participatory action research, which have renewed how the environment is taught and learned (Roman Acosta et al., 2023). These tools enable environmental education to be a relevant and attractive subject for students of all ages. However, significant challenges remain, as environmental education is often addressed superficially in many school curricula (Kolandai et al., 2023).

There is also a gap between academic research in this field and practical application in real educational contexts (Galecka Drozda et al., 2021). This study provides an analysis of sources published in the last five years on specific knowledge and topics in environmental education related to nature conservation (Stępniewska, 2021). Scientific output is systematically analyzed to identify the topics receiving the most attention, the approaches that achieve the best results, and the areas that require further theoretical and practical analysis. The results of the research form the basis for improving public policies, training programs, community initiatives, and others. It also contributes to the dialogue between education as a fundamental pillar and the need to build a more sustainable future concerning nature (Murgas Téllez et al., 2023).

Methodology

The methodology applied for this article has a bibliometric approach and has gone through seven essential steps. The first of these focuses on the design of the research. This is followed by the search strategy, data processing and filtering, the indicators analyzed, qualitative content analysis, limitations, and methodological conclusions. The bibliometric approach allowed for the analysis of scientific production in terms of environmental education and its impact on nature preservation.

This made it possible to quantify trends, address collaboration networks, thematic patterns in academic literature, and the most relevant authors. The search strategy took into account the terms environmental education and nature preservation. The authors consulted key databases such as Scopus, Web of Science, and Google Scholar.

Different selection criteria were applied, including articles published between 2019 and 2023 in Spanish and English, which were scientific articles, systematic reviews, and book chapters with a focus on environmental education applied to ecosystem conservation. For data processing and filtering, an initial extraction was performed. The metadata, including the title, authors, year, journal, citations, and keywords, were downloaded from these databases.

The data was then cleaned. Duplicates were removed using tools such as Zotero bibliographic managers, and documents that were not relevant were excluded based on a reading of the titles and analysis of the abstracts. VOSviewer software was used for the bibliometric analysis. This allowed the authors to map keyword co-occurrences and analyze productivity indicators and trends. In addition, we took into account the number of publications per year, the most influential authors and institutions based on the number of publications and citations, collaboration networks, the most recurring keywords, and the journals with the greatest impact on the topic.

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Subsequently, the qualitative content was analyzed. The most cited articles were identified, and an in-depth analysis of the main aspects they addressed was carried out. In addition, the most recurrent methodological approaches were identified, such as case studies, reviews, and pedagogical proposals. The most effective educational strategies for environmental preservation were also analyzed.

Among the main limitations is the bias of the databases, since many regional journals were not indexed in Scopus or Web of Science. Furthermore, most of the texts consulted were published in English. This approach made it possible to identify and visualize the state of the art in environmental education in terms of ecosystem and nature conservation. Research gaps and future opportunities were identified.

Results

The bibliometric analysis identified some patterns in scientific output related to environmental education as a strategy for nature conservation in the five years from 2019 to 2023. Initially, 487 documents indexed in the Scopus, Web of Science, and Google Scholar databases were identified. In the last two years, there has been an annual growth of more than 18% in publications on the subject.

The geographical distribution is concentrated in Western Europe, with more than 35% of studies; North America, with 28%; and Latin America, with almost 22%. Other notable countries are Spain, the United States, and Brazil. Together, these countries account for 42% of the countries with the highest number of publications in total production (Figure 1).

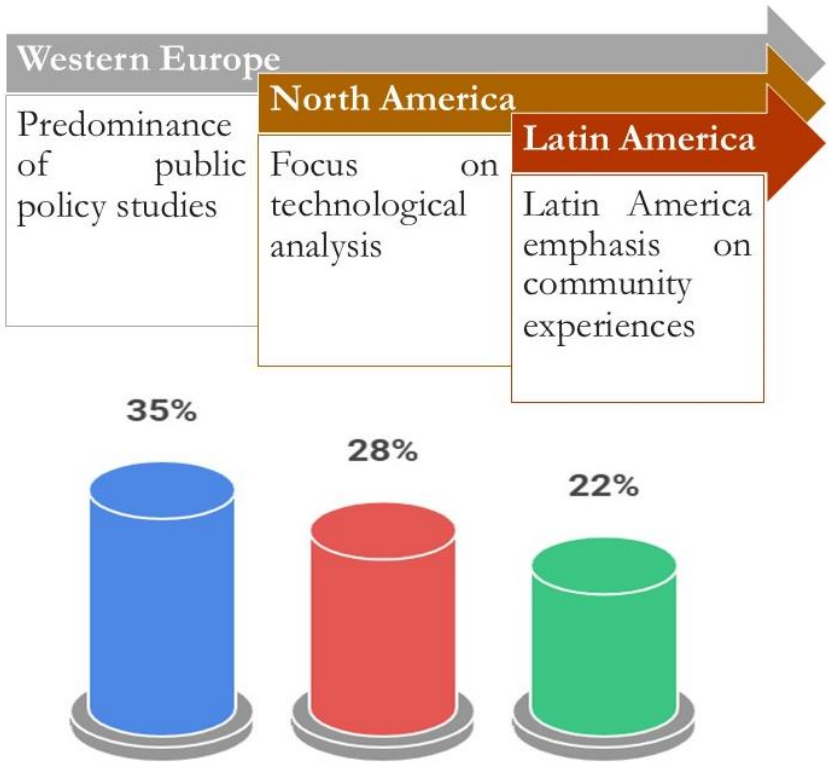

Figure (1) Geographic Distribution of Research in Environmental Education (2019-2023)

This reflects the different thematic approaches that exist depending on the region. Studies related to public policy predominate; in Europe and Latin America, the focus is on community experiences and case studies, and the topics analyzed include technological aspects related to nature conservation. The analysis made it possible to identify co-authorship networks using VOSviewer.

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In the first cluster, Spanish and German universities specialized in formal education and studies on school curricula (Lee & Liu, 2023). This was followed by a predominance of institutions in Latin America, especially in Brazil and Mexico, which focused on popular education and traditional knowledge (Knozowski et al., 2023). Thirdly, universities in the United States and Canada analyzed educational technologies and augmented reality applied to nature preservation and the development of environmental awareness.

There was a transition in research approaches between 2019 and 2020, with more than 32% of publications analyzing how studies had pedagogical foundations. Between 2021 and 2023, research had an applied function in more than 67% of cases. The most frequent keywords in this last time range were community participation, critical pedagogy, and impact assessment, indicating a shift toward increasingly practical and transformative approaches (Villalba & Useche, 2021).

The citations were analyzed, and the articles that received more than 100 citations each were highlighted (Figure 2). These had common characteristics such as conceptual and integrative frameworks, proposed models for educational intervention, and combined qualitative and quantitative methods (Tam, 2022). The study revealed how quasi-experimental designs associated with educational programs generated more relevant changes than one-off interventions.

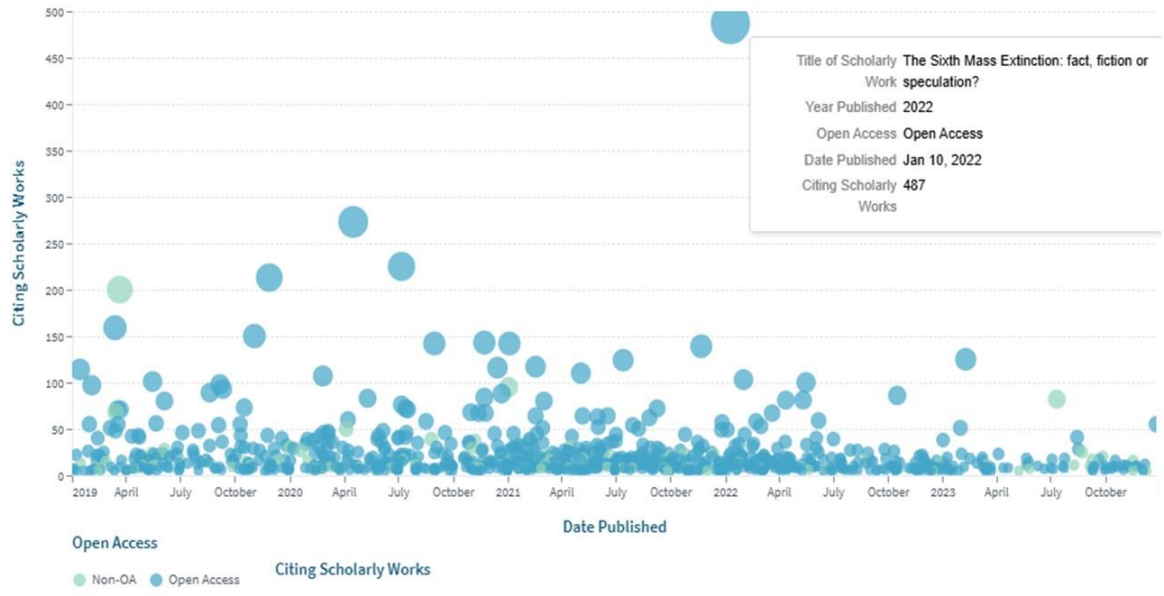

Figure (2) Citation Map and Frequency

Among the journals with the highest number of publications, Environmental Education Research stands out, with more than 18% of articles, followed by Journal of Environmental Education and Sustainability. These two journals accounted for almost 30% of the total. It is noteworthy that publications in high-impact journals increased during the period, suggesting greater visibility and recognition of these issues in the academic field.

The predominant methodology in the studies analyzed was mixed, accounting for 54% (Arroix Jiménez et al., 2023). Qualitative approaches exceeded 32%, and quantitative approaches exceeded 14%. Participatory action research, especially in the Latin American context, reached a progressive stage. The age groups that were the focus of the study stood out, with more than 38% of the research focused on adolescents, and studies focused on teachers, 25% (Figure 3). No studies associated with environmental education in the elderly were found.

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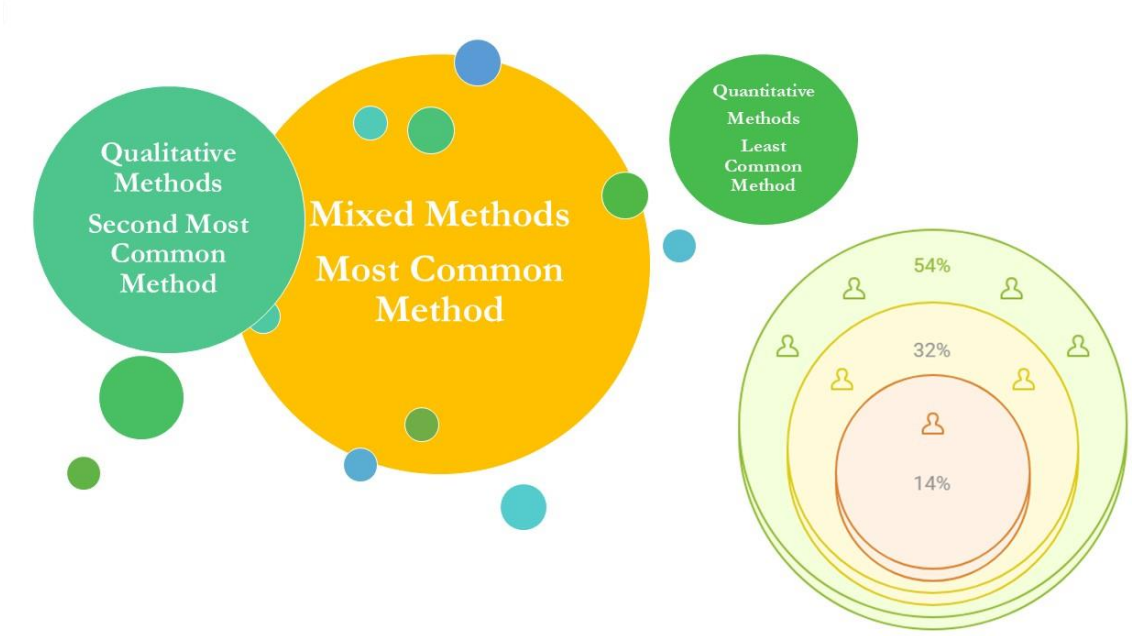

Figure (3) Research Publications in Environmental Education

The citation analysis revealed, among the main theoretical trends, the emancipatory critique associated with Paulo Freire's critical pedagogy, the cognitive behaviorist trend based on theories associated with behavioral change, and the complex systems trend (Zhang et al., 2023). This was integrated into an ecological vision. In turn, the latter showed growth in the last two years of the period analyzed. Emerging areas were identified in 2023, particularly environmental education linked to technology, mental health, and environmental justice (Mihardja et al., 2023). These topics suggest new lines of research to be included in the academic agenda of the future.

Discussion

Bibliometric analysis shows how environmental education is becoming established as one of the priority fields of study for nature conservation (Arévalo Zurita et al., 2023). Scientific publications have shown sustained growth over the last five years. This demonstrates international recognition of how to implement technical and political solutions that go beyond mere government or institutional procedures and take into account the recognition of environmental education as an element for transforming the relationship between nature and society (Haque & Sharif, 2021) (Figure 4).

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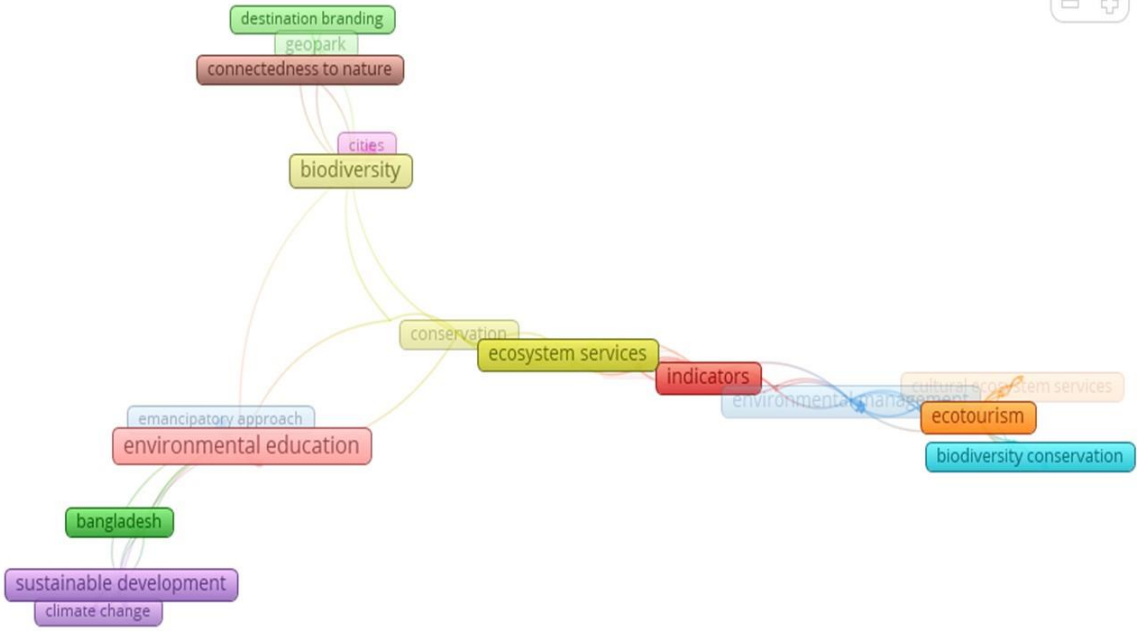

Figure (4) Keyword Co-Occurrence Map

Scientific production is concentrated in Western Europe, North America, and Latin America. The search for sources in the latter geographical context was intentional, based on an analysis of inclusions and research on the subject, as there is evidence of inequality in knowledge generation, and this geographical region has specific characteristics due to its large natural reserves (Pinheiro et al., 2022).

However, regions with high biodiversity, such as Africa and Southeast Asia, are not prominently represented in the academic literature of the last five years. Collaboration clubs show how complementary approaches are integrated with each other, but slowly (Schulz et al., 2019). From the point of view of formal education in the European context, academic studies predominate.

In Latin America, analyses of community knowledge are presented, while in North America, research has a technological connotation (Suárez Perales et al., 2021). All of this suggests the need to create international spaces for dialogue in which the strengths of each region can be integrated. Latin American experiences have a notable presence of popular education. This rarely transcends language barriers or is only published in journals in databases that do not reach Scopus and Web of Science, despite its proven effectiveness (Więckowski, 2023).

The transition from theoretical studies to applied research is a significant element in this area. There are no studies that take into account long-term impact assessment (Olvera Hernandez et al., 2023). There is also a limited understanding of the behavioral changes that result from the implementation of environmental education for nature conservation (García Jiménez et al., 2021).

Among the most successful educational programs are those that take an interdisciplinary approach, linking global issues with the active participation of communities in program design and implementation (Duran Izquierdo & Olivero Verbel, 2021). This contradicts the tendency of many systems to approach environmental education as isolated content taken out of context.

Mixed methodologies predominate in this type of research. This shows an important step forward in methodological maturity. Debates about quantitative and qualitative approaches have been overcome (Ghafraoui et al., 2023). Longitudinal and comparative studies show shortcomings in the region, which makes it difficult to analyze and identify patterns at the global level. The importance of environmental education is mainly focused on academic studies related to how teachers impact the subject and how

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adolescents relate to it (Neto & Henriques, 2022). There are no studies focused on older people. This is noteworthy given that this age group has an influence on consumption patterns and decision-making in the family environment.

Among the theoretical currents, emancipatory criticism, cognitive behaviorism, and complex systems theory stand out. These show epistemological fragmentation, although they do demonstrate conceptual richness in the field of study (Yakusheva, 2019). The emergence of complex systems theory shows a shift toward more comprehensive views of the human-nature relationship. This approach allows for the integration of concepts associated with ecology, complex thinking, and adaptive systems (Chikodzi et al., 2022). It also shows how they address the global challenges associated with climate change.

Important conceptual and methodological challenges arise among the different thematic areas. Technology-mediated environmental education accounts for more than 28% of the articles. This requires more effective studies that take technological risk into account. Complex pedagogical dilemmas are also highlighted, associated with how to maintain the urgency of environmental action without it being lost among the younger generations (Alvarez Codoceo et al., 2021). From an educational perspective, environmental justice also highlights inequalities in access to quality environmental education, especially in vulnerable communities that are disproportionately affected by environmental impacts (Giezen & Pellerey, 2021).

The different results highlight an important issue to be analyzed: the effectiveness of traditional educational strategies, which focus on the transmission of information (Okubo, 2023). The programs with the greatest impact take into account the components of knowledge development, promotion of values, strengthening of practical skills, and the creation of spaces for real participation. This allows for the integration and analysis of how brief and isolated interventions have limited effects. In turn, programs that manage to be sustainable achieve more profound cultural changes (Tápanes Suárez et al., 2023).

Seventy percent of publications are concentrated in specialized journals on the subject. This focus is positive, but it has an impact on quality processes. It also indicates a certain homogenization with regard to academic discourse. Many of the innovative experiences documented in books and book chapters are not captured by bibliometric indices, which creates a bias in the overall understanding of the field (Krieger, 2023).

Technical reports and local journals that do not make it into the databases analyzed are also not taken into account. This highlights the paradox that, while academic literature on the subject is increasing, indicators associated with environmental deterioration continue to worsen (Potsikas et al., 2023). This dichotomy suggests that urgent collective action is needed that goes beyond the transmission of knowledge, is capable of resisting dominant economic systems, and achieves a greater leap forward than the actions that have been developed without positive results (Suárez Rojas et al., 2023) (Figure 5).

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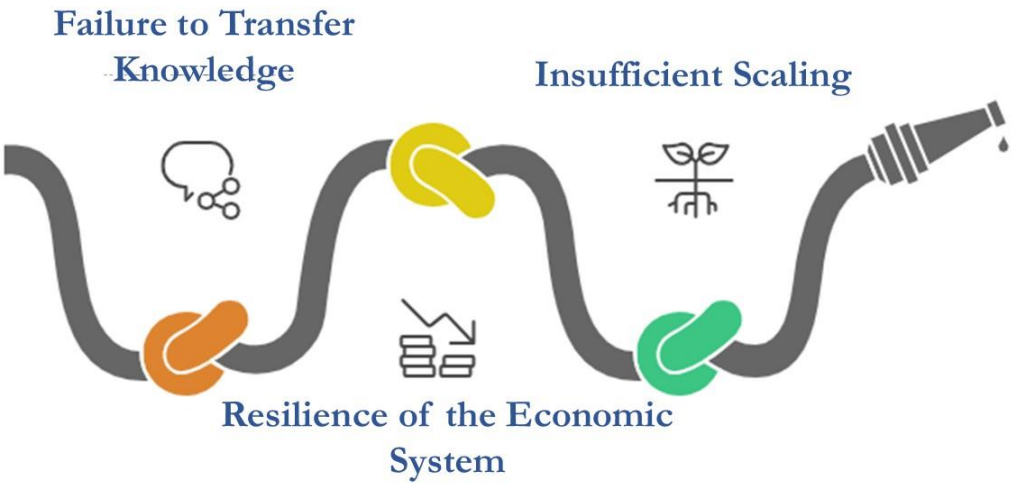

Figure (5) Research Publications in Environmental Education

The challenge lies not only in producing knowledge about environmental education, but also in ensuring that this knowledge can be applied and replicated in public policies, in the transformation of educational practices, and in enabling communities to take direct action to protect the environment. Environmental education studies face the challenge of transcending an approach based on solving environmental problems and generating preventive and creative analysis that allows for the construction of more sustainable societies (Pérez Guedes & Arufe Padrón, 2023).

This requires more interdisciplinary studies that strengthen the links between science and politics, recognize that education must have a strong environmental component, and show an interest in educational environmental justice, in which power structures are recognized and confronted, and an analysis of the contemporary ecological crisis can be carried out (Vogiatzakis et al., 2020). The topic and its evolution based on bibliometric analysis show how environmental education is moving from an instrumental vision to increasingly critical and political approaches (Nekrasova et al., 2022).

This is important because, in the wake of ecological crises, technical problems are being analyzed, but so are the unsustainable models of civilizations (Hipólito et al., 2019). Education cannot be limited to providing individual changes; it must be able to take on criticism of economic and cultural structures without losing its transformative capacity in the face of increasing challenges. Studies focusing on urban contexts predominate and reveal a significant gap in relation to rural and indigenous dynamics (Barrado & Prados, 2022).

That is why studies located in Latin America, especially in the Amazon region, were taken as a reference. These types of communities have more direct relationships with ecosystems and, in turn, have valuable ancestral knowledge that allows for greater preservation. However, the representation of these communities in academic literature is insufficient (Khan et al., 2023). Environmental education requires intercultural models that integrate scientific knowledge with other worldviews and empirical knowledge. Effective educational programs link learning with actions associated with ecosystem restoration and conservation (Melo et al., 2021).

The subjects involved must learn about environmental issues and seek solutions that actively contribute to generating empowerment processes that go beyond the cognitive. All of this shows how discursive methodologies require greater investment to adapt to practical projects that can achieve measurable

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economic and ecological impacts (Samal & Dash, 2023). The emotional dimension is not present in most of the studies analyzed.

This constitutes a limitation in the field of study, since the relationship with nature is not only a cognitive link; it also requires an emotional connection and sensory experiences (Vieira et al., 2022). This dimension cannot be ignored in the various programs that are implemented, as they fail to connect the deep motivations that guide human behavior toward nature conservation. The growth of research on technology-linked environmental education shows the need for more specific analyses based on how the real effects of technologies are linked to nature (Bhuiyan et al., 2021).

Many applications increase and identify educational platforms and diversify them, while at the same time reducing direct contact with ecosystems (Hyytiäinen et al., 2022). Technology broadens the scope of environmental education, but it cannot replace the physical and sensory experience of the natural world, especially for children, adolescents, and young people. Most of the publications identified were in English. This creates a limitation in terms of the dissemination of local and regional knowledge (Araque Geney, 2023).

In many cases, research on the subject cannot be published because it does not meet the formal requirements of international journals (Moraes et al., 2021). This shows a homogenized view of environmental education, which is unable to reflect the diversity of realities and approaches that exist between different cultures and regions.

Studies show that environmental education requires broader time frames that are at odds with short-term projects promoted by dominant public policies (Tavárez & Elbakidze, 2021). Reconnecting with adolescence and changing habits requires continuous and specialized support (Kagohashi & Fujimoto, 2019).

This clashes with political cycles and evaluation systems that expect immediate results rather than profound transformations. There is a need to rethink how the training of environmental educators can transform teaching and learning (Boix Fayos et al., 2023).

Different programs must have an interdisciplinary approach that goes beyond formal higher education spaces. Professionals must integrate pedagogical and social knowledge with ecological knowledge and take into account the complex challenges of contemporary environmental crises (Higuera Carrillo, 2022). Education demands a revolution in teacher training models that is not generally apparent in the literature reviewed.

Conclusions

Bibliometric analysis identified how environmental education is becoming one of the most important fields of study for nature conservation. There has been growth in applied research and interdisciplinary approaches. However, significant gaps remain in academic output and the implementation of concrete actions that could slow or halt environmental degradation. The most effective strategies are those that link scientific knowledge with community participation and go beyond individual theoretical or behavioral limits.

The results also show the need for urgent action and consideration of the geographical and cultural inequalities that are evident in the generation of knowledge on the subject. In many regions, scientific production is concentrated in areas that are not necessarily vast territories with high biodiversity. Ancestral knowledge is also not visible in the specialized literature, and texts published in English predominate. All this asymmetry shows the need to transform environmental education and incorporate intercultural approaches that can integrate different ways of understanding and relating to nature.

It also shows how educational programs have essential characteristics linked to their interrelation with local issues, the inclusion of participatory methodologies, and the incorporation of emotional and long-term

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approaches. All of this demonstrates how traditional technologies have a limited impact, as they prioritize information over practical experiences. They do not take into account the collective, and the results seek to be increasingly immediate without considering the profound processes associated with cultural change.

Education for preservation requires more radical transformations, especially in formal education systems and in public policies with an environmental focus. The study shows that environmental education requires in-depth analysis to articulate traditional and popular knowledge in innovative pedagogical proposals. It is necessary to overcome fragmentation in theoretical approaches and seek links with community action, which is one of the greatest challenges. Environmental education needs to be critical and committed to ecological and social justice in order to respond to the crises we face.

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