BIBLIOMETRIC REVIEW OF THE FOREST AS A TOOL FOR ENVIRONMENTAL EDUCATION

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Resumo

Revisão bibliométrica da floresta como instrumento da educação ambiental. O contato com a floresta iniciado na infância, possibilita a construção de valores em relação à natureza. Estudos de bibliometria, podem auxiliar na busca de trabalhos sobre o tema floresta. Assim, o objetivo deste trabalho foi analisar o panorama geral das pesquisas científicas sobre as atividades de educação ambiental relacionadas à floresta, através da caracterização bibliométrica nas bases WoS e Scopus. Os trabalhos foram filtrados a partir de códigos de busca que abrangiam o tema. Foram verificados todos os artigos, considerados válidos os que realizam atividades de educação ambiental e utilizaram como base a floresta. A filtragem resultou em 102 artigos, destes, 62 artigos foi possível efetuar uma análise metodológica. Foram encontrados artigos de 37 países, com maior número para os EUA e 274 autores diferentes, mas a maioria (93,4%) publicou apenas um manuscrito. Na análise metodológica, a maioria engloba o ensino não formal em atividades de educação ambiental pontual. A floresta em geral é utilizada para trabalhos com foco em percepção e sensibilização ambiental, e as técnicas de interpretação ambiental mais utilizadas são as práticas de campo, em trilhas interpretativas guiadas e autoguiadas. Mais de 50% dos artigos não justificam o método aplicado e vários trabalhos mostram falhas metodológicas que dificultam replicar as práticas em outros estudos. Conclui-se na análise bibliométrica, que há uma variedade de autores falando sobre o assunto, mas não foi identificado um autor especialista de referência. As falhas metodológicas encontradas comprovam os desafios de se obter avanços científicos em educação ambiental a partir da floresta.
Palavras-chave: educação florestal, bases indexadoras, percepção ambiental, metodologia científica.

Abstract

The contact with the forest started in childhood enables the construction of values with nature. Bibliometric studies can help in the search for works on the forest theme. Thus, the objective of this work was to analyze the general panorama of scientific research on environmental education activities related to the forest, through bibliometric characterization in WoS and Scopus databases. The works were filtered from search codes that covered the theme. All articles were checked, and those that carried out environmental education activities and used the forest as a base were considered valid. The filtering resulted in 102 articles, of these, 62 articles it was possible to carry out a methodological analysis. Articles from 37 countries were found, with a greater number for the USA and 274 different authors, but the majority (93.4%) published only one manuscript. In the methodological analysis, most include non-formal teaching in specific environmental education activities. The forest in general is used for works focused on environmental perception and awareness, and the most used environmental interpretation techniques are field practices, in guided and self-guided interpretive trails. More than 50% of the articles do not justify the applied method and several works show methodological flaws that make it difficult to replicate the practices in other studies. It is concluded in the bibliometric analysis that there are a variety of authors talking about the subject, but a reference specialist author was not identified. The methodological flaws found prove the challenges of obtaining scientific advances in environmental education from the forest.
Keywords: forestry education, index bases, environmental perception, scientific methodology.

INTRODUCTION

The environment consists of several interrelated components, such as the forest, the most important element for ecological stabilization, in addition to its economic and social role (CHLPOSOVA *et al.*, 2020). Within a forest ecosystem, there are several biotic and abiotic components, such as flora, fauna, microorganisms, water, soil, and subsoil, where each component performs different ecological functions (AHRENS, 2005).

The forest, as part of environmental education, not only in terms of content but also in its direct contact, allows children to build values in their relationship with themselves, with the people around them, and with living and inanimate nature (CHLPOSOVA *et al.*, 2020). According to the same authors, living in contact with nature, mainly in experiences that started in childhood, reflects physical and emotional benefits.

Pedrini and Saito (2015) reflect on the dissemination of information on environmental education for a given reality. These authors engaged in resolving a specific, consolidated, and shared paradigm, felt the need for

more in-depth theoretical and methodological studies in the field of environmental education, using the same rules and standards in scientific analysis.

The bibliometric review is a tool that synthesizes a given topic, group methodologies, and associates result from a group of authors, as well as observing gaps and identifying the development of new knowledge (REYNAUD; TODESCAT, 2017; PEREIRA *et al.*, 2019).

Bibliometric methods use publication databases to build structural images of scientific fields, introducing a measure in the evaluation of scientific literature, and are mainly used in performance analysis and scientific mapping (ZUPIC; ČATER, 2015). Through quantitative means and bibliometric indicators, it is possible to analyze the scientific production and the quality of research on a given subject and measure the performance of journals, universities, and researchers (RAVELLI *et al.*, 2009; VAN RAAN, 2014; PEREIRA *et al.*, 2019).

Both Web of Science (WoS) and Scopus are indexing bases that promote increased visibility of publications and function as publication channels and dissemination of research results, being the most used indicators for comparing and classifying journals in academia (ABRIZAH *et al.*, 2013; QUARTIERO; SILVA, 2017).

Bearing in mind the questions raised and the importance of the forest and its role in actions for environmental education, this study aimed to evaluate the general panorama of scientific research on environmental education activities related to the forest, through the bibliometric characterization in the main indexing bases and evaluation of the methodology of the works for its scientific propagation.

MATERIAL AND METHODS

The bibliometric evaluation of the use of the forest as a tool for environmental education was carried out based on the analysis of publications on the subject, following the methodological process of the sequence presented in the flowchart of FIGURE 1.
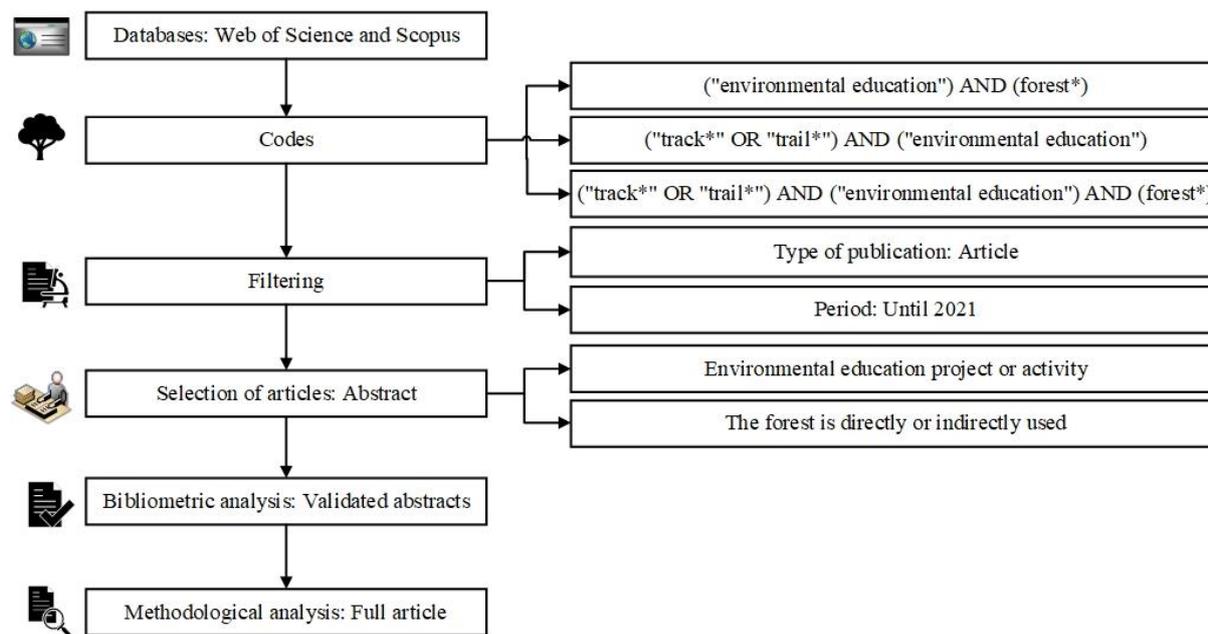
Figure 1. Flowchart of the methodological steps used to collect bibliometric data
Figura 1. Fluxograma das etapas metodológicas utilizadas para a coleta dos dados bibliométricos

The data used were obtained from the database of two of the most prominent indexing bases in the international context. They index bibliographical productions from the best-published journals, such as Web of Science, developed by Thomson Scientific - Institute for Science Information (ISI), and Scopus, launched by Relx Group (QUARTIERO; SILVA, 2017).

To cover the largest number of works on the subject, we used a combination of terms that reflect the object of study in English. It is important to emphasize that the study is a sampling of existing publications on the subject and not a census, given that not all scientific journals are indexed in the platforms used.

The search was performed by inserting the following combination codes: ("environmental education") AND (forest*); ("track*" OR "trail*") AND ("environmental education") AND ("track*" OR "trail*") AND ("environmental education") AND (forest*) in the databases, in the TOPIC (Web of Science) and TITLE-ABS-KEY (Scopus) options, which covers words in the titles, abstracts and keywords of all works indexed in the Web of Science and Scopus.

The works defined for this study were all scientific articles available in the databases by the year 2021. As two databases were used, the filtering showed an initial number of publications that were organized in an Excel database, removing repeated works between the bases.

The summaries of all filtered articles available in the database were accessed and read, and selected according to the following criteria that reflect the focus of the research:

1) The articles describe projects or activities of environmental education;
2) They use the forest or fragment of the urban forest directly or indirectly for environmental education.

From the selected works, the individual metrics of each publication were downloaded through the export of data from the platform of the analyzed bases to carry out the bibliometric study.

The following parameters were analyzed from the works that met the established criteria:

• Year of publication of the articles;
• Country of origin of the articles and their impact according to their citations;
• Name of the journal;
• Authors - forming a web of interconnection between the main authors;
• Keywords - forming a web of relations between the main keywords;
• Study area - it was verified in which country the environmental education activities were carried out.

To generate information on the analyzed parameters, the VOSviewer program version 1.6.16 was used. As the program evaluates the databases of the platforms separately, the Web of Science standard was adopted, joining the bases in a single document. To generate the tables, the base was added in the Create tab *Create → Create a map based on bibliographic data → Read data from bibliographic database files → Web of Science*. After this procedure, the type of analysis was chosen and a "*thesaurus file*" was added to each parameter, a file with synonymous words, to avoid the repetition of terms.

From VOSviewer, an interconnection network was generated between the authors with the highest level of influence present in the database through the *Co-authorship* tool. To investigate the most used keywords in the articles, the same program was used through *co-occurrence* analysis, selecting the *author keywords*, option; that is, the keywords added by the authors in the articles, but all keywords could be used, which include those added in their works, but also those indexed on the journals' platforms during manuscript submissions.

The second step was to evaluate the complete articles written in Portuguese, English, and Spanish, with free access for download or with paid access, but which were available free of charge on the CAPES platform, through the link with the teaching institution Federal University of Paraná.

In these articles, the state of the art was assessed and, consequently, gaps in the application of environmental education associated with forests, evaluating information regarding:

• Scope of the work - the main purpose that the environmental education activities addressed was verified, grouping them into similar themes;
• Type of environmental education - whether it was formal (environmental education activities developed in the curricula of public and private school teaching institutions) or non-formal (actions and educational practices aimed at environmental awareness outside the school curriculum) (BRASIL, 1999);
• Target Audience;
• Activity monitoring - if it was punctual (one or more activities and no monitoring) or continuous (several activities and continuous monitoring);
• Approaching methodology for environmental education activities - divided into fourteen methods (Table 1);
• Methodology has support from other scientific works - yes or no;
• Evaluation method of project participants - the evaluation methods of activities were verified concerning the target public, grouping similar evaluations;
• Evaluation is supported by other scientific work - yes or no;
• Is it possible to replicate the proposed method - yes or no?

Table 1. Learning methodologies associated with environmental education
Tabela 1. Metodologias de aprendizagem associada à educação ambiental

Modality	Methods	Definition
Formal	Forest School	Outdoor learning processes.
	Piaget	Psychology of learning from cognitive structures.
	Traditional	Pedagogical view centered on the educator (teacher), the contents are transmitted by the professor to the students, through the subjects.
	Others	Other Methods in Formal Education.
	Publications	Any type of publication that serves as a support for environmental interpretation such as maps, leaflets, posters, roadmaps, and guides.
	Guided Interpretive Trail	The tour in the natural environment is conducted in the presence of an interpreter or guide who performs environmental interpretation.
	Self-Guided Interpretive Trail	The tour in the natural environment is self-explanatory through other interpretative means, such as signs and panels.
Formal/ Non-formal	Walk	Sporting practice along a nature trail.
	Artistic Interpretation	Through role plays, folk demonstrations, artistic demonstrations, and games.
	Lecture	A speaker mediates information about the environment.
	Field Practice	Classes experienced in the natural environment.
	Exhibitions	Objects and/or documents that illustrate or partially explain an interpretive theme, such as models and samples.
	Workshops	Learning through the implementation of environmental education activities.
	Multimedia	Used to help the interpretation through audiovisual objects.

SOURCE: Adapted from Carvalho *et al.*, 2002; Harris, 2021; Higuchi *et al.*, 1996.

All data were tabulated using Microsoft Excel, where tables and graphs were created to better visualize the results obtained.

RESULTS

From the codes used in the survey, 1,278 works were obtained, of which 969 were scientific articles. As two databases were used, it was necessary to check for duplicate documents, resulting in 737 articles. All of the abstracts of these articles were read and those that met the selection criteria were selected, resulting in 117 articles. In the second stage, access to these articles was verified, of which it was possible to access 77 complete articles for a more specific analysis of the subject. As 15 works did not meet the established criteria, they were discarded, thus resulting in 102 articles in the bibliometric analysis with the application of the VOSviewer program, of these, 62 articles were for a specific analysis of the work's methodology (Table 2).

Table 2. Selection of articles for bibliometric analysis
Tabela 2. Seleção de artigos para na análise bibliométrica

Basis	Code	Number of works	Total Number of Articles	Number of Different Articles	Number of Selected Abstracts	Number of Complete Articles
Web of Science	1	340	263	248	40	29
Web of Science	2	86	62	48	10	6
Web of Science	3	17	13	12	4	0
Scopus	1	649	503	357	40	22
Scopus	2	157	110	67	6	4
Scopus	3	29	18	5	2	1
Total		**1278**	**969**	**737**	**102**	**62**

Legend: 1 = ("environmental education") AND (forest*); 2 = ("track*" OR "trail*") AND ("environmental education"); 3 = ("track*" OR "trail*") AND ("environmental education") AND (Forest*).

In the number of articles per year, works that relate to the forest in environmental education were registered by the databases for the first time in 1984, with approximately nine years without works on the subject, returning in 1994. The highest concentration of works can be verified from 2010, with 75.5% of the

articles validated for this research and the year with the highest number of published articles was 2018, with 16 works.

Regarding the country of origin of the works, 37 different countries were observed, with the largest number of articles for the United States of America with 21.01%, followed by Brazil (14.29%) and England (5.88%). Although these countries published a greater number of articles, when analyzing the number of citations, the only work produced by Nepal had a higher efficiency in the average number of citations per publication, with 41 citations, followed by Germany, with an average of 36 citations, and Madagascar, with 35 citations.

Concerning the places of publication, the 102 articles were distributed in 75 journals from different countries. The journal with the highest number of articles (5) and citations (182) was "*Environmental Education Research*", while the journal with the highest article/citation ratio was "*Environmental Conservation*", with a ratio of 44 citations per article. As it is a holistic theme, the theme permeates the scope of several journals, including 58 journals with only one article. The journals with the highest number of articles were: '*Environmental Education Research*" (5), "*Journal of Forestry*" (4), and four journals with three publications each, the "*American Journal of Primatology*", "*Environment, Development and Sustainability*", "*Environmental Conservation*" and "*Journal of Environmental Education*".

When verifying the main authors who relate environmental education to the forest, 273 different authors were found. The maximum number of articles produced by an author was three articles (Dreyer, J. M. and Sugiura, K), but most of the authors, 93.4%, contributed with only one article, among them, the most cited article was produced in 2013 by the authors "Lieflander, A. K.; Frohlich, G.; Bogner, F. X.; Schultz, P. W.", entitled "*Promoting connectedness with nature through environmental education*".

The interaction network of the main words, with at least four occurrences, resulted in 10 more relevant keywords, the most frequent being the term "environmental education" with 69 occurrences, followed by "education", "conservation" and "forest" with 18, 14 and 13 occurrences respectively. The web of relationships is represented in Figure 2.
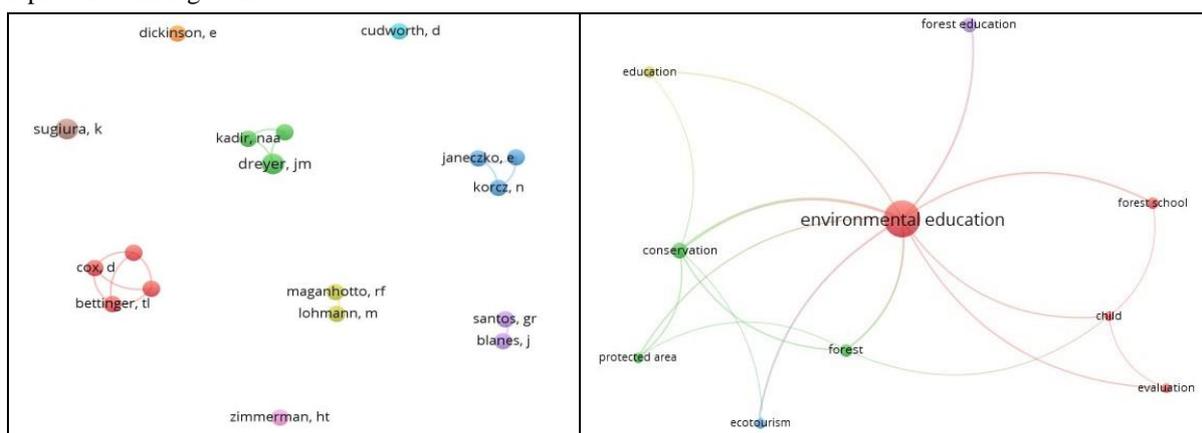
Legend: Above the list of the most frequent authors; below the web of relation of the main keywords.
Figure 2. Web of list of authors and most frequent keywords
Figura 2. Teia de relação dos autores e palavras-chaves mais frequentes

Checking the area of study of the articles, the papers report projects carried out in 34 countries, but 14 articles did not report the nationality of which the environmental education project was about. The countries with the largest number of works were Brazil (17.6%), followed by the United States (13.7) and Japan (4.9).

Regarding the analysis of the complete articles, the scope of the works was evaluated, resulting in five main themes, the most frequent being projects that work with environmental education through perception (40.32%), followed by environmental awareness with 20.97% of the total (Figure 3).

Perception	40.32%
Environmental awareness	20.97%
Conservation of species	17.74%
Project diagnosis	17.74%
Research	3.23%
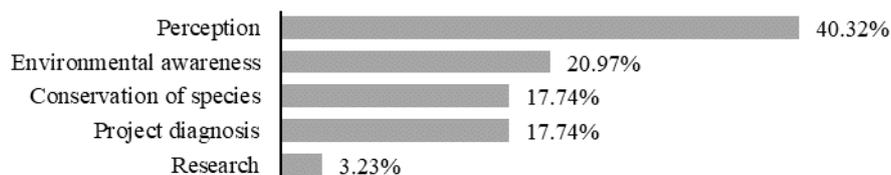
Legend: **Perception** – Works that verify the organization and interpretation of sensations for an awareness of the environment, through the representation of the forest; **Environmental awareness** – Works that apply EE activities intending to raise awareness about the environment; **Conservation of species** – Works that apply EE activities for the conservation of some animal or plant species; **Project**

diagnosis – Works that analyze EE activities in forested areas; **Research** – Works that perform EE activities in the forest encompassing data collection for research.

Figure 3. Main topic of full articles
Figura 3. Tema principal dos artigos completos

Regarding the modality of environmental education, most of the works were carried out in non-formal teaching activities (62.90%), and, of these, the majority were occasional (87.18%) that is, developed without continuous monitoring. Whereas, for activities in the formal teaching modality (38.10%), most of the activities took place continuously (65.22%), with monitoring of the activity for a pre-established period by the project.

Regarding the target audience, most of the articles were focused on environmental education projects including children and adolescents (55.07%) in the school period of the basic education network, of which most of the works do not mention the age group; followed by visitors (17.39%), as it includes articles involving visits to green areas; 2.90% was not possible to identify the target public, due to lack of clarity of the articles (Figure 4).
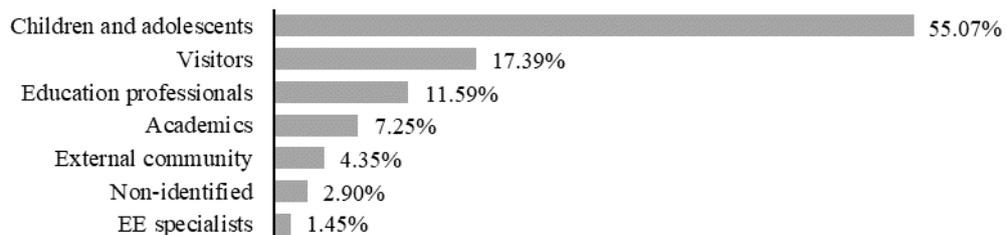
Legend: **Children and adolescents** – Environmental education activities (EE) focused on children and adolescents; **Visitors** – EE activities for a diverse audience visiting a natural area; **Education professionals** – EE activities with professionals working in the school; **Academics** – EE activities with students from higher education; **External community** – EE activities with the children's parents or residents of the region; **EE Specialists** – Assessment of EE activities with a subject matter expert.

Figure 4. Target audience covered in the full articles
Figura 4. Público-alvo contemplado nos artigos completos

Regarding the approach method for environmental education activities, 40.22% used a specific method, 36.96% used two methods, and 22.83% used three methods, the most prominent being "Field practice" (15.22%), followed by "Self-guided interpretive trail" and "Guided interpretive trail", each representing 11.96% (Figure 5).
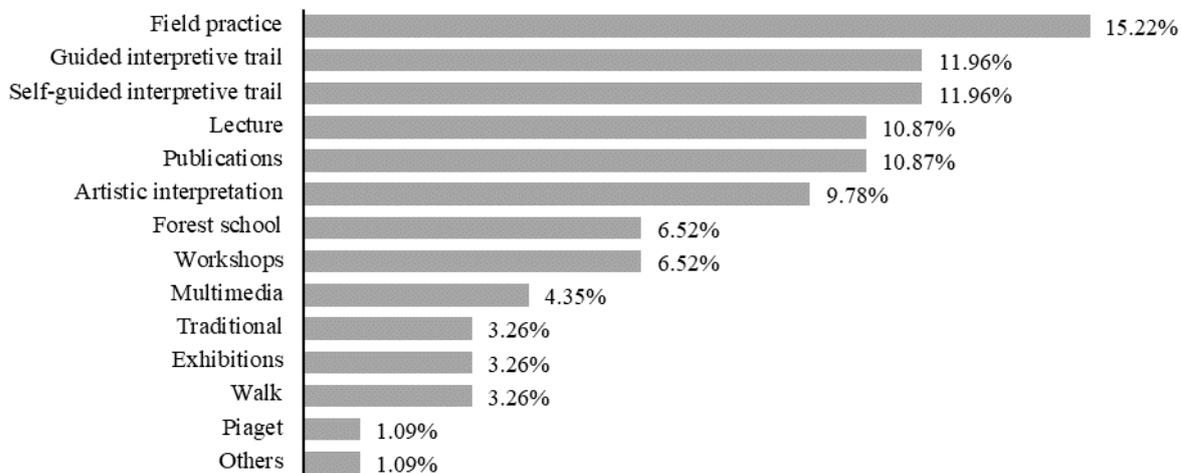
Figure 5. Distribution of approach methods covered in the full articles
Figura 5. Distribuição dos métodos de abordagem contemplados nos artigos completos

In addition to the type of method used in the works, it was evaluated whether the articles chose the method based on scientific support, that is, whether the method chosen was based on other works. Just over half (51.61%) of the articles did not make clear the scientific references used to choose the method used.

As for the method of evaluating the effectiveness of the activity developed concerning the target audience, the works were grouped into eight groups (Figure 6), verifying that most (44.62%) were through a questionnaire, followed by interviews and works that did not carry out any assessment, with 18.46% each. Analyzing the reason for choosing these methods based on scientific support, 62.90% of the articles did not make clear the choice of method.
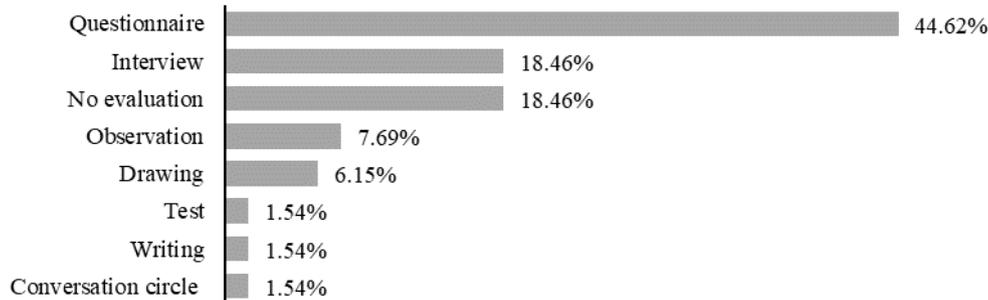
Legend: **Questionnaire** – Form with questions related to EE activity; **Interview** – Questions about the EE activity with the direct interaction between the research and the interviewee; **Observation** – Formulated through observation of the researcher concerning the target public in EE activities; **Drawing** – Assessment of activities through mental maps; **Test** – Questions related to EA activity with grades; **Writing** – Essay text about the EE activity; **Conversation circle** – Chat between the researcher and the target audience about the EA activity.

Figure 6. Environmental education assessment method applied in full articles
Figura 6. Método de avaliação da educação ambiental aplicada nos artigos completos

Finally, it was analyzed whether the methodology of the articles could be replicated with the information present in the articles and it was diagnosed that in 56.45% of the works, it would not be possible, as some questions such as the content addressed in the chosen environmental education methods, the model of the questionnaire and the questions for the interviews.

DISCUSSION

The resumption of works relate to the forest in environmental education in 1984 may be related to the historic milestone of Rio 92. It was the First United Nations Conference that involved civil society as a whole, included the environment in the global public agenda, and elaborated the "Treaty on Environmental Education for Sustainable Societies and Global Responsibility"; the greater number of articles from 2010, however, may be related to several environmental tragedies that occurred that year, such as floods in the Asian continent, a tsunami in Indonesia, earthquake in Haiti and fires in Russia (SOUSA *et al.*, 2011).

In a study by Júnior *et al.* (2020), verifying the dissemination of environmental education in public education, the most relevant journal was *Environmental Education Research*. According to the same authors, this journal covers a wide range of topics in the area of environmental studies, education, and educational research and, as it is associated with environmental education, it is a scientific means to propagate research in the area, as well as the *Journal of Environmental Education*, to promote a constructive critical debate on environmental education and sustainability.

By analyzing the web of interaction between the authors, the present work shows that the interaction occurred in the research group, a fact that may be related to the low number of publications among the authors, showing that with the databases used (Web of Science and Scopus), there is no reference author on the subject. Regarding the keywords, environmental education permeates all groups, as expected, considering that it was the objective of this work to evaluate the articles on this subject, but it is also possible to verify two groups of articles: those that associate environmental education with studies that link the forest, protected areas and conservation and another that links forest school, children and evolution.

In verifying the methodology of the articles, some flaws were identified, such as the description of the study area and target audience, which are essential for the reader to be able to make connections between the research and the context of the region analyzed. For Köche (2011) for a greater understanding, identification, and evaluation of scientific work, some information is needed, such as describing and characterizing the sample.

Several works have as their main target audience children and adolescents. This fact may be correlated with the statement by Morhy *et al.* (2020) that children are always willing to discover new things, so pedagogical practices that include environmental education and their relationship with the environment from an early age are fundamental because they can help at the perception and behavior regarding the environment, redefinition of values, environmental principles and the feeling of belonging to the planet.

The child's direct contact with the natural environment helps build values in the relationship with itself, but also with living and inanimate nature, in addition to studies showing that man's relationship with nature since childhood results in physical and emotional benefits in adulthood (CHLPOSOVA *et al.*, 2020).

Roos and Becker (2012) report that projects with studies that encompass generative themes from a theoretical-practical basis can use, for example, field trips, lectures, and workshops, which serve as subsidies for the school community, as well as for any citizen who has some knowledge in the environmental area and who wish to develop small intervention projects. For Korkmaz *et al.* (2018), projects that aim to involve people

through the experience of the active action of the participants in the natural environment generate significant learning and an affective bond with nature.

Some examples of activities in non-formal education are carried out on interpretative trails, such as the work carried out by Nascimento *et al.* (2017), which cite the illustrative means of the forest, to provide activities that reveal the meanings and characteristics of the environment, through direct connection with nature. Other works are associated with the perception of visitors to conservation units and their relationship with the unit or factors that interfere with the forest, such as the research carried out by Korcz *et al.* (2021), who checked whether users observed climate change in forests.

Regarding formal teaching, some works report actions in the traditional teaching method, using field practice as a support didactic strategy, as is the case of the work carried out by Dolins *et al.* (2010), who describes a program called "Children and Trees Growing Together". This program involves teachers, parents, and children in improving the school environment through reforestation, with one of the activities being planting and monitoring plant growth.

Other works were developed through non-conventional teaching practices, such as articles that report the students' experience using the *Forest school* methodology, which is based on outdoor learning in the forest and in the place where the child is inserted, through games, where learning is conducted by the child, as is the case of the work of Harris (2021), that verified the students' connection with nature or the connection with the place while attending the *Forest School*. Some studies use Piaget's constructivist methodology, such as the one developed by Higuchi *et al.* (1996), in which ways of representing the Amazonian ecosystem were analyzed and compared with elementary school students, based on games and group activities with cognitive levels.

In addition to the type of method used, authors must indicate the references that motivate them to test the chosen method in their work. In a bibliometric analysis carried out by Souza *et al.* (2019) on environmental education and education for sustainability in works published in events, it was verified that 95.08% of the works do not cite the research method used and the main techniques of data collection were questionnaire and interview.

King (2015) mentions that for a work to be replicated, enough information is needed for the reader to be able to reproduce it without needing additional information from the author, this does not mean arriving at the same results, but it is possible to support new research.

Thus, to strengthen the field of research in environmental education, aiming at continuous improvement for an awakening of conscience concerning forests and the environment in which we live, it is important to carry out studies with an adequate methodological structure, to obtain advances in future studies.

CONCLUSIONS

- The criteria established through the selected search codes covered a wide range of articles, but most of them were not within the scope of the study and were discarded, a common fact in bibliometric research, bearing in mind that the articles are filtered if the terms are present in the title, abstract or keyword list of the works.
- In the bibliometric analysis of the selected articles through the most prominent indexing bases in the international context (Web of Science and Scopus), it was evidenced works distributed in several countries and different journals, not showing a reference author on the subject, noting that even when defining a specific theme for the area, it is difficult to verify a group of researchers consolidated in the theme.
- Regarding the methodology of the 62 articles analyzed, a variety of methods were found, but most without a clear scientific justification for the use of the chosen methods, making it difficult to replicate, propagate and use a given method as a reference for studies of environmental education and forestry, proving the holistic scope of the theme and the challenges in responding to scientific paradigms in the area of environmental education and forestry, bearing in mind that only articles from the Web of Science and Scopus indexing bases were considered.

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