BIBLIOMETRIC ANALYSIS OF THE INTERNATIONAL SCIENTIFIC PRODUCTION ON ENVIRONMENTAL EDUCATION

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Abstract. *Environmental Education has become over recent decades an emerging area of knowledge; its evolution has been conditioned not only by different regional dynamics, but also by international guidelines and trends. Therefore, the literature reports multiple and diverse pedagogical, curricular and transdisciplinary approaches to this topic. Likewise, studies on the dynamics and trends in the generation and production of knowledge are relevant to both teachers and researchers in every field of knowledge. In this sense, it is presented a bibliometric study that aims to analyse the international scientific production on Environmental Education on the Web of Science (WoS) within the categories Education and Educational Research and Education, Scientific Disciplines for the last two decades (2000-2019). The information obtained was analysed using different bibliometric techniques, like descriptive statistics, degree of collaboration and co-occurrence maps generated by VOSviewer (version 1.6.15) software. The results show the accelerated increase in the production of knowledge in this area, they present the main research contexts, as well as some educational and research perspectives. Also, the collaboration between authors and universities was identified.*

Keywords: bibliometrics analysis, environmental education, scientific education, scientific production

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Introduction

Environmental Education was conceived in the late 60s, when what it is known today as the Club of Rome (1968) was founded. Club of Rome was a non-governmental organization formed by businessmen, scientists, and politicians from 52 countries. The main principle of this community was to show that the current growth patterns would lead to an imminent depletion of natural resources, to the erosion of ecosystems and to regional and global environmental crises. For this reason, Club of Rome ordered a report from a group of researchers at the Massachusetts Institute of Technology (MIT), led by Meadows (Meadows et al., 1972). The MIT report stated that any deliberate attempt to achieve a lasting and rational state of balance, made through planning rather than through chance or catastrophe, should find its ground in a change of values and goals individually, nationally, and globally. Therefore, this event revealed the need to develop a full-scale strategy to face major problems, including in particular, those that represent humankind's relationship with environment.

Therefore, 1972 stood out as a year of changes or at least proposals for changes; in fact, it was the first significant moment regarding Environmental Education, because The United Nations Conference on the Human Environment was held in Stockholm this year (United Nations, 1973). This was the first conference about environment and important global environmental problems were discussed there. Furthermore, the Conference on Environmental Education held in Tbilisi (UNESCO, 1978) pointed to the need to transform the educational systems and to rethink them considering environmental problems, equity and social and ecological justice, and the world as a complex system. Likewise, Tbilisi Declaration (UNESCO, 1978) requested the member states to include in their educational policies measures to incorporate into their educational systems environmental education contents and strategies based on the general objectives and guidelines established there; also, the educational authorities were invited to reinforce and promote reflection, research, and innovation in Environmental Education.

In the following years, different elements were provided for an international strategy of education and training in the environment field; principles, characteristics, typologies, agents involved, and research guidelines were recognized in order to answer the environmental problems of the moment (UNESCO, 1987). However, it was in the Brundtland report (World Commission on Environment and Development, 1987) where the concept of sustainable development was developed and one of the strongest lines in Environmental Education began to consolidate: Education for Sustainable Development (ESD). This fact and the Conference of Río (Guimaraes, 1992) spread a very relevant message: there can be no economic growth without a sustainable environment, and education, at all levels, is where sustainability should be promoted.

ESD (UNESCO, 2002) allows every person to acquire the knowledge, skills, attitudes and values needed to build a sustainable future (Novo, 2009). Instructional education could be reformulated around sustainability, in this sense, Vilches Peña and Gil-Pérez (2016) considered that transition to sustainability should not be seen, nor considered at the educational level, as a bet for the future that requires sacrifices now: it is, on the contrary, a well-founded strategy to solve the problems that the humankind is already experiencing. It is about involving teachers, students and citizens in general, to satisfy the current needs from the humankind (not just from a minority), without harming the future. Something that the current recipes to "get out of the crisis", which is not only economic, cannot achieve.

Therefore, international guidelines have been adopted in multiple contexts - for example, the 2030 Agenda or the Sustainable Development Goals-, and public policies have been developed to strengthen and promote environmental education and to give it a transdisciplinary connotation. This has favoured linking environmental topics with different areas of knowledge in several educational contexts (formal, non-formal or informal). In addition, research studies which theorize, generate and systematize different experiences, have appeared, and studying them allows knowing the different patterns of knowledge generation in this field.

From this perspective, Environmental Education gives relevance to education, participation, research, and evaluation. Likewise, some recurring actions carried out are: collaboration in the creation and maintenance of infrastructures and networks of information and documentation for the use of associations; creation of local, regional, national and international associations that allow a more active social presence; establishment of cooperation agreements between associations in order to develop common initiatives, design and make good use of resources and materials, or coordinate effective and long-term programs; finally, promotion for the incorporation of environmental education in international development cooperation programs, in collaboration with organizations and universities from different countries.

In this sense, the literature allows recognizing the need for a deep conceptualization in Environmental Education and transcending from merely informative processes to others that transform the educational reality and allow systemic and critical thinking, participation and collaboration, and without a doubt, emotional bonding, in formal contexts (educational centres), as well as in non-formal ones. According to different authors, the increasing interest in environmental issues has also increased the production of knowledge on this field (Abraham et al., 2015; González & Puente, 2010; Medina Arboleda & Páramo, 2014). In fact, Environmental Education is nowadays considered as a relevant and interesting research and academic field. This has led to the publication of different documents, including reflections, literature reviews and empirical research.

Maz-Machado et al. (2020) argued about the need for bibliometric studies that analyse the dynamics and trends in the generation and production of knowledge. They considered that this kind of studies allows knowing the state of a field of knowledge and the production patterns of countries, regions or institutions, recognizing its strengths and even motivating political or scientific measures. In addition, bibliometric studies allow knowing more about patterns of research of a field by identifying for example the main countries, authors, institutions, keywords, research clusters, topics addressed, collaboration networks, etc. (González-Alcaide et al., 2018; Maz-Machado et al., 2015).

In this sense, literature review and bibliometric studies in Environmental Education allow reconstructing the history of the research in the field in local and global contexts, knowing the prevailing pedagogical trends, the epistemological and methodological obstacles, etc. Therefore, in recent years different bibliometric studies about Environment and Environmental Education have been made worldwide, for example Abraham et al. (2015), Hallinger and Chatpinyakoop (2019), Prosser Bravo and Romo-Medina (2019), etc.

In order to do this kind of studies, Medina-Arboleda and Páramo (2014) suggested expanding the inclusion of journals from different areas of knowledge in the searches, considering that environment implies transdisciplinarity. The same opinion about transdisciplinarity in the field manifested Papadimitriou and Kidman (2012). They analysed the journal *International Research in Geographical and Environmental Education* and they stated that although themes like teacher education, values and attitudes, inquiry and problem-solving were recurrent through

the years, the thematic diversity of articles was high.

On the other hand, Onopriienko et al. (2021) stated that:

> Conducting a bibliographic analysis according to the keywords "environmental education" it can be argued that the diversity of views on this thematic cluster is high. At the same time, each author in one way or another mentions the dialogue between man and nature, which is impossible without environmental education of young people and adults. Environmental education of adults is becoming especially relevant and requires qualitative changes, the latest methods and approaches, the use of international experience. (p. 6)

These studies show the growing interest for bibliometric studies in Environmental Education and the different views that these studies can offer. All things considered, this research aimed to know the international annual production in Education and Environment (E&E); to identify the most productive universities on this field; to know the topics with the greatest presence in the analysed documents according to their descriptors and the pattern of co-occurrences in the articles; to determine the degree of collaboration in authorship; and finally, to identify the journals included in SSCI that publish E&E documents.

Research Methodology

General Background and Sample Selection

This research is an exploratory and descriptive study. In March 2020, WoS was consulted, and the *Social Sciences Citation Index* (SSCI) database was selected from the main collection. Later, it was searched within the category Field of WoS the term <<Environmental Education>> from 2000 to 2019. 10855 documents were obtained corresponding to the entire database SSCI. Then, the data was refined by choosing the categories *Education & Educational Research* and *Education, Scientific Disciplines*, in order to ensure that all documents were related to educational aspects. Finally, using this filter, 2419 documents were obtained.

The described filter allowed ensuring that all the documents correspond to Education and Environmental Education themes. However, due to this filter other documents that address this topic may have been left out, therefore, the study is of a sample nature.

Instrument and Procedures and Data Analysis

All the considered documents were systematized in an ad hoc database, using Microsoft Office 2019 software (Access and Excel). Then, a process of standardization of the names of the educational institutions was carried out, due to the fact that different variants were found for the same institution.

The variables taken into account were: year, affiliation of the authors, name of the journal, number of authors per document, and descriptors; both, the ones defined by the authors and the Keywords plus given by WoS based on the cited references (Mangan, 2019). Then, the frequencies of each of the variables were extracted. Furthermore, the co-occurrence network (co-words) in the documents for the descriptors and Keywords plus was determined.

To assign the authorship of each document, all individuals identified as authors in the selected documents were included and counted equally. Only personal (rather than corporate) authors were included in this study.

In order to determine the collaboration patterns in authorship, the number of authors of each document was counted and then, to find the Degree of Collaboration (DC), the formula proposed by Subramanyam (1983) was used. This indicator has been used in various studies in science and social sciences (Pinto et al., 2015). Thus, for a collection k of articles published in a journal, these indicators are defined as:

$$DC = 1 - f_1/N$$

Where $0 \leq DC \leq 1$.

f_j = Number of articles with exactly j authors in a collection k, so f_1 is the number of articles with exactly one author in a collection k.

N = Total number of articles in k.

The affiliation of the signing authors was taken into account to identify the collaboration that occurs between universities and then, the collaboration network was represented using the VOSviewer version 1.6.15 software

(Van Eck & Waltman, 2020). Collaboration between countries was determined based on the number of authors from each country.

The entire methodological process followed in each step is explained in the following data processing diagram (Figure 1).

Figure 1
Diagram of the Data Processing
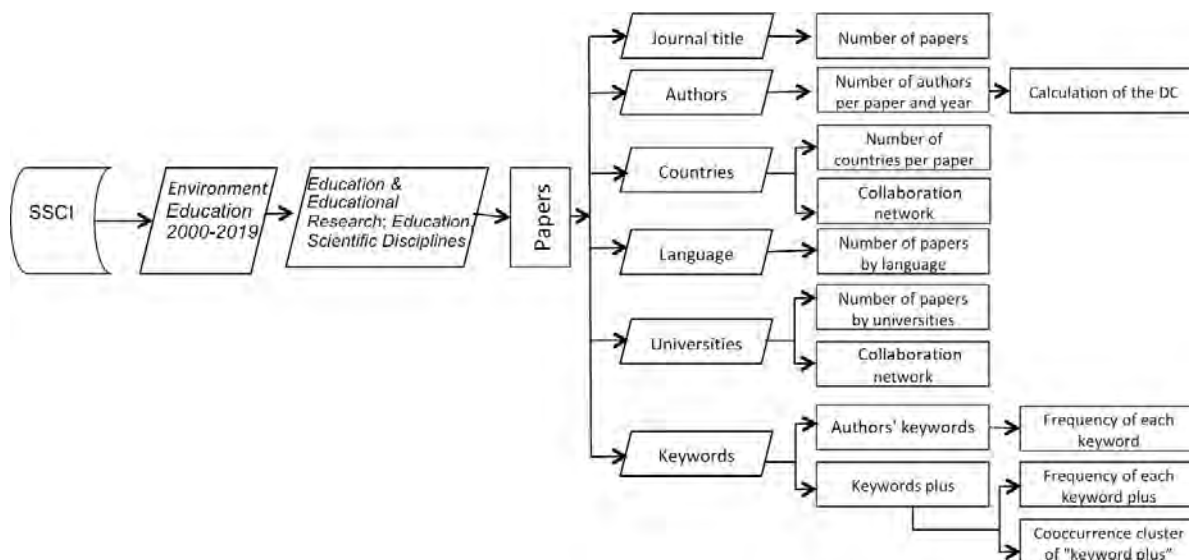
Research Results

The analysis shows a total of 2419 documents about E&E indexed in the two SSCI categories, *Education & Educational Research* and *Education, Scientific Disciplines*. In relation to the language of publication, 96.7% of the documents were published in English (Table 1); this agrees with the fact that English is the main language for the international dissemination of scientific knowledge in this database.

Table 1
*Language of Publication of the Documents Analysed*

Language	N	%
English	2340	96.73
Spanish	50	2.07
Turkish	17	0.70
Other	12	0.50
Total	2419	100.00

The year of publication of the documents revealed an increase in the production over the 20 years analysed, because only 10 documents were published in 2000 while 319 were published in 2019. However, this increase has not been consistent over the years (Figure 2). For example, from 2005 to 2012 there was a gradual increase in production, then, the production decreased slightly until 2015, since then it has increased and in 2019 the maximum production, until that moment, was achieved. To sum up, the behaviour of the production can be represented with a linear model with an R=0.912 adjustment.

Figure 2
Annual Production on Environmental Education in SSCI (2000-2019)
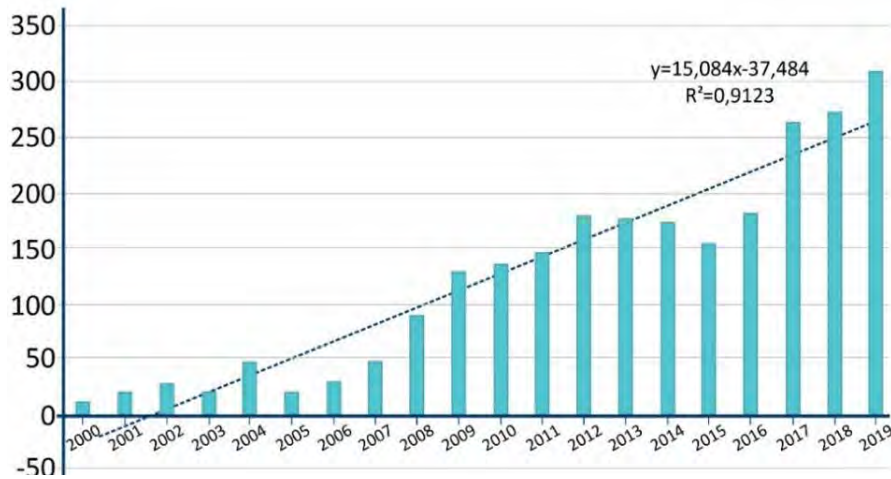
There may be several reasons behind this behaviour. For example, it could be influenced by national and international events about environment and environmental education or by emerging lines of research.

Considering every document included in the analysis, articles are the most common form of publication, they represent 92.02% of all documents (Table 2).

Table 2
Type of Publication of the Documents Analysed

Type of Document	N	%
Article	2226	92.02
Editorial material	71	2.94
Review	69	2.85
Proceedings paper	32	1.32
Book	14	0.58
Others	7	0.29
Total	2419	100.00

Research articles were published in 235 journals. 64.3% of these journals are from the United States of America, 17.9% from the Netherlands and 3.8% from Turkey. Table 3 shows the 20 journals which have published more documents about E&E, they published 60.2% of the total documents. It is noteworthy that among these journals, in 11th position, it was found *Enseñanza de las Ciencias*, which is published in Spain and its language of publication is Spanish.

Table 3
Top 20 WoS Journals that Publish on Environmental Education (2000-2019)

Journal	N	%
Environmental Education Research	557	23.03
Journal of Environmental Education	189	7.81
International Journal of Sustainability in Higher Education	154	6.37

Journal	N	%
International Journal of Science Education	90	3.72
Journal of Geography in Higher Education	53	2.19
Eurasia Journal of Mathematics Science and Technology Education	40	1.65
Science Education	37	1.53
Research in Science Education	35	1.45
Journal of Research in Science Teaching	32	1.32
Journal of School Health	30	1.24
Enseñanza de las Ciencias	28	1.16
Health Education Research	27	1.12
Higher Education	25	1.03
Journal of Science Education and Technology	25	1.03
International Journal of Educational Development	24	0.99
Journal of Baltic Science Education	24	0.99
Nurse Education Today	24	0.99
Journal of Biological Education	22	0.91
Bmc Medical Education	21	0.87
Journal of Nutrition Education and Behaviour	20	0.83

Considering the origin of the authors of the documents included in the analysis, the study found 91 different countries. More than a third of the publications on E&E come from the United States of America, as Table 4 shows. Then, documents come also from Australia and the United Kingdom, which have a similar number of documents published (219 and 218 respectively). Among the most productive countries from Latin America are included Brazil with 47 documents, Mexico with 16 documents and Colombia with 6 documents.

Table 4
Top 20 Countries with the Highest Scientific Production on Environmental Education

Country	N	%
USA	813	33.61
Australia	219	9.05
United Kingdom	218	9.01
Canada	177	7.32
Turkey	136	5.62
Sweden	118	4.88
Spain	108	4.46
China	77	3.18
Germany	75	3.10
Netherlands	67	2.77
Israel	65	2.69
Taiwan	61	2.52
Brazil	47	1.94
New Zealand	44	1.82
South Africa	43	1.78

Country	N	%
Belgium	39	1.61
Greece	37	1.53
Finland	36	1.49
Scotland	36	1.49
South Korea	26	1.07

Considering the collaboration among countries, it is possible to divide these countries into 13 groups. The biggest group includes the United States of America, which has collaborated in E&E scientific publications with 40 countries; it is followed by England, which has collaborated with 36 countries, Australia with 34, and Spain with 31 (Figure 3). All Latin American countries are related to Spain, except Perú, which is related only to the USA. Figure 3 shows the collaboration network between countries, the size of the nodes is determined by the production on this topic per country.

Figure 3
Collaboration Network among Countries
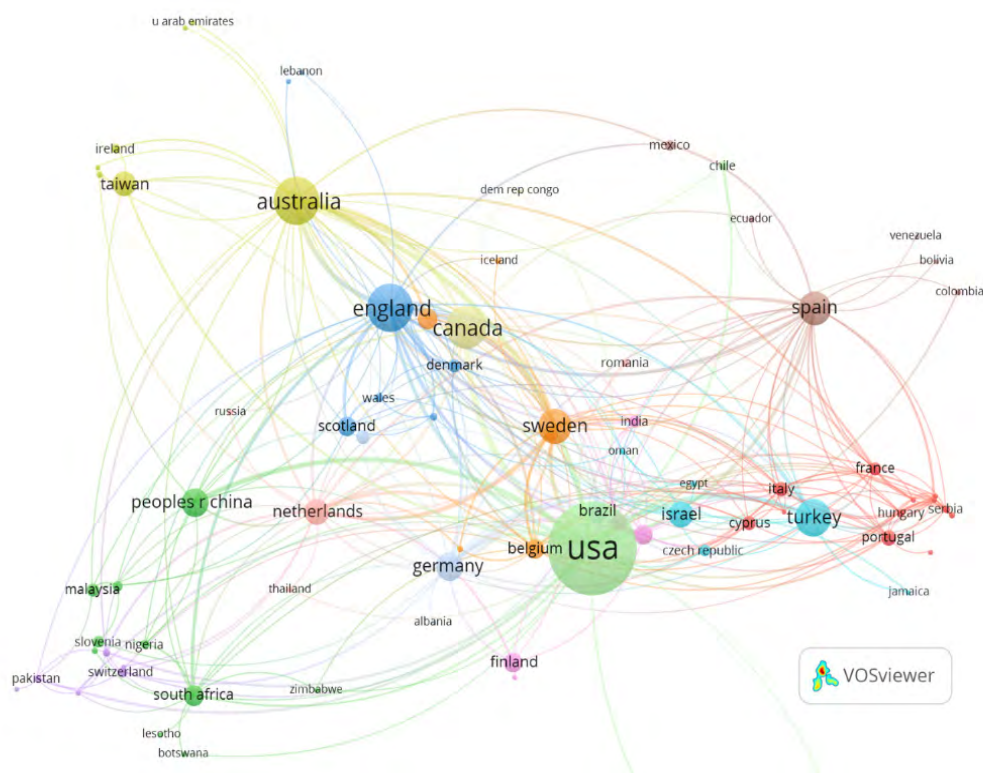
These 2419 documents were signed by 4710 different authors, this generated 6410 signatures, because several documents were signed by more than one author, in particular, the average number of authors per article is 2.64. Also, it was found that 688 documents (28.44%) were signed by a single author, 707 (29.23%) by two authors and 485 (20.05%) by three authors. Two documents were signed by 17 authors and this is the maximum number of authors per document found. In total, 71.56% of the documents were published collaboratively.

The Degree of Collaboration (DC), which was calculated for biannual periods, shows that in the last 6 years (since 2014) the DC has achieved its maximum and it has remained constant since then (Table 5). The DC for the entire period is 0.89, this value confirms the existence of collaborative networks in scientific production in E&E.

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Table 5

Degree of Collaboration (DC) in Authorship

Period	2000-01	2002-03	2004-05	2006-07	2008-09	2010-11	2012-13	2014-15	2016-17	2018-19	Total
DC	0.87	0.81	0.74	0.81	0.80	0.88	0.88	0.92	0.92	0.92	0.89

The authors of the documents included in this analysis belong to 1233 different research institutions (every institution with at least one signatory author in one document was considered). It should be noted that in 44 documents no information about the institutional affiliation of the authors was found. Table 6 shows the universities that participate in the co-authorship of more than 20 documents. This table shows that the production is led by the University of North Carolina and followed by the University of California System. The first European university is the University of London (UK), it has 34 documents, and it is in 5th place (shared with other universities), the next European institution is Stockholm University. The first university from Oceania is the Monash University (Australia). The University of Sao Paulo (Brazil) is the first South American institution, and it has 8 documents.

Table 6

Universities with the Highest Production in Environmental Education on WoS

University	N	%	University	N	%
University of North Carolina	47	1.94	Stockholm University	24	0.99
University of California System	42	1.74	Pennsylvania State University University Park	23	0.95
Monash University	39	1.61	University of Gothenburg	22	0.91
State University System of Florida	37	1.53	University of Minnesota System	22	0.91
Pennsylvania Commonwealth System of Higher Education Pcshe	34	1.41	Middle East Technical University	21	0.87
California State University System	34	1.41	Purdue University	21	0.87
University of London	34	1.41	Purdue University System	21	0.87
Cornell University	30	1.24	University of Wisconsin System	21	0.87
University System of Georgia	30	1.24	Clemson University	20	0.83
Deakin University	27	1.12	University of Florida	20	0.83
Pennsylvania State University	27	1.12	University of Washington	20	0.83
Virginia Polytechnic Institute State University	24	0.99			

The authors provided 4719 descriptors and the descriptors assigned by WoS (based on the titles of the cited references - *Keywords plus*) were 2624. Figures 4 and 5 show the co-occurrence among the descriptors (the greater the co-occurrence, the bigger the size of the circles and the labels). The words in English were used, in order to facilitate interconnections and to avoid the possible noise due to the different denominations and languages, this is recommended in various bibliometric studies (Pinto et al., 2015).

The co-occurrence maps generated for each set of descriptors differ in the word with the greatest accumulation of density, in the authors' descriptors (figure 4) the map is denser around "environment education" while in the *Keywords plus* (figure 5) the greatest density is around "education". Considering *Keywords plus* are more objective than those provided by the authors, the research focus was their analysis.

Figures 4 and 5 shows respectively, a 2D view of the original 3D co-occurrence map of authors' descriptors and 3D co-occurrence map of descriptors *Keywords plus* assigned by *WoS*. The different nodes represent the different descriptors, and their size is determined by the frequency of apparition of each descriptor. The lines link each descriptor with the other keywords that appear with it (co-appear).

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Figure 4
Co-occurrence Map of Authors' Descriptors

Figure 5
Co-occurrence Map of Descriptors Keywords Plus Assigned by WoS

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Descriptors whose frequency is higher than a thousand are "Education" which appears in 71.4% of all documents, and "Knowledge" in 54.6%, they both appear in more than half of the publications (Table 7). Although the descriptor "knowledge" is not recognizable in the 2D view figure, it would be recognizable on the 3D original map.

The first descriptor of environment or environmental education is "Environmental-education" which appears in 19.65% of documents and then "sustainability" in 12.4%.

Table 7

Most Frequent Keywords in Environmental Education and Education

Keyword	N	%	Keyword	N	%
Education	1726	71.4	Beliefs	346	14.1
Knowledge	1321	54.6	Higher-education	342	13.0
Science	974	40.3	Values	314	12.7
Attitudes	955	39.5	Teachers	308	12.6
Students	917	37.9	Health	305	12.4
Behaviour	687	28.4	Framework	299	12.4
Model	514	21.2	Sustainability	299	12.2
Perceptions	514	21.2	Curriculum	295	11.7
Impact	475	19.6	Achievement	284	11.5
Children	474	19.6	Literacy	277	11.2
Environmental-education	474	19.6	Management	272	10.9
School	361	14.9	Experiences	264	10.9
Performance	350	14.5	Science-education	264	14.1

In order to know more about the descriptors directly related to the environment, the keywords plus obtained in our data have been filtered using a truncation on the right side with the word "environment *". By doing so, 226 descriptors were obtained. Most of them, 69.75%, are included in less than 5 documents. Table 8 shows those that are included in 10 or more documents.

Table 8

*Terms that Incorporate "Environment" 10 Times or More*

Terms	Frequency	%
Environmental education	429	17.73
Environmental literacy	37	1.53
Environmental attitudes	33	1.36
Environmental awareness	19	0.79
Environmental knowledge	18	0.74
Environmental sustainability	18	0.74
Environmental behaviour	17	0.70
Environmental science	12	0.50
Pro-environmental behaviour	12	0.50
Environmental action	12	0.50
Pro-environmental behaviour	11	0.45
Environmental issues	10	0.41

Additionally, a co-occurrence map of these filtered descriptors was created (Figure 6) and in order to have a more concrete view of these in the analysed documents, they were grouped by clusters of at least 6 elements. Table 9 presents the descriptors grouped into 11 clusters and the main topics that made the formation of clusters possible. These topics were inferred from the analysis of the different clusters.

Figure 6
Co-occurrence Map of the Descriptors Related to "Environment"
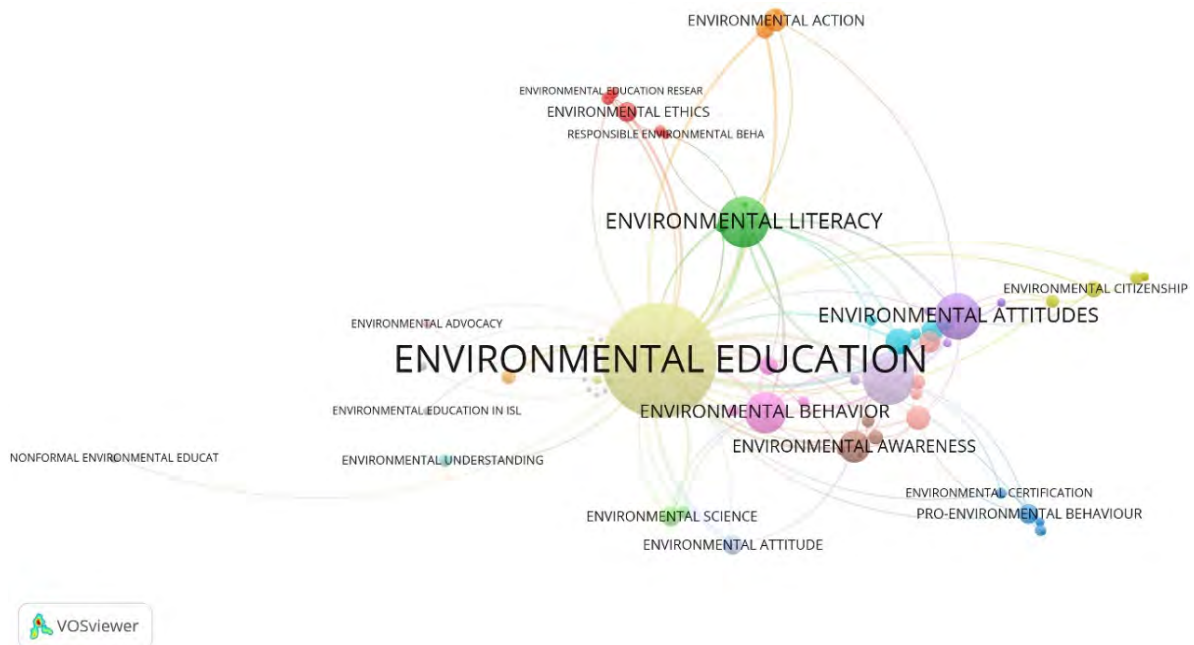
Table 9
Clusters of at Least 6 Elements for the Descriptors that Include Environment

Clusters	Descriptors	Main topics
Cluster 1 (9 items)	Environment, environment protection, environmental, environmental attitude scale, environmental awareness, environmental consciousness, environmental education curriculum, non-formal environmental education, youth environmental volunteers.	Contexts of Environmental Education -where it is applied
Cluster 2 (8 items)	Environmental concern, environmental health, environmental identity, environmental optimism, environmental racism, environmental sustainability, pro-environmental behaviours, school environment.	Environmental Education and alternative perspectives -different ways of thinking about the environment
Cluster 3 (8 items)	Environmental behaviours, environmental citizenship, environmental leadership, environmental responsibility, environmental views, multicultural environmental projects, private-sphere environmentalism, socio-environmental projects.	Projects about Environmental Education –as main strategy-
Cluster 4 (8 items)	Built environments, environmental activism, environmental certification, environmental learning, environmental service learning, experimental environmental education, integrated environmental teaching, pro-environmental behaviour.	Didactic approaches in Environmental Education -teaching, learning and evaluation
Cluster 5 (8 items)	Environmental behaviour, environmental concerns, environmental motivation, Environmental values, experiential environmental education, model of responsible environmental behaviour, pro environmental behaviours, pro environmental behaviour.	Attitudinal issues: beliefs, values, responsibility.
Cluster 6 (7 items)	Children's environmental attitudes and knowledge scale, environmental attitudes, environmental education evaluation, environmental worldview, environmentally friendly behaviours, environmentally responsible behaviour types, sponsored environmental campaign.	Affective and emotional connection with the environment.

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Clusters	Descriptors	Main topics
Cluster 7 (7 items)	Environment defined, environmental attitudes and values, environmental competences, environmental insight, environmental literacy, environmental management systems, environmentally responsible behaviour.	Components of environmental literacy.
Cluster 8 (7 items)	Environmental campaign, environmental curriculum, environmental information, environmental knowledge, environmental surveys, environmental values and attitudes, pro-environmental behaviour.	Knowledge and attitudes in Environmental Education.
Cluster 9 (7 items)	Brazilian environmental education, environmental aesthetics, environmental and sustainability education, environmental education and scientific conferences, environmental education research, postgraduate environmental education, scientific production on environmental education.	Spreading of knowledge in Environmental Education
Cluster 10 (7 items)	Constructivist learning environments, critical environmental education, environmental action, environmental interconnectedness, environmental issues, responsible environmental behaviour, urban & built environments.	Teaching approaches in Environmental Education and sustainability.
Cluster 11 (6 items)	Environmental management, environmental research, environmental science, environmental studies, environmental workshop, university environmental awareness.	Research Exercises in Environmental Education.

Discussion

Firstly, the research highlights that Environmental Education has become more popular over recent years and it has been a focus of interest in the production of knowledge, from both educational (curricular and didactic) and research fields. This interest is reflected in the increase in the production of scientific articles, especially between 2009 and 2014 and between 2017 and 2020. These results are consistent with other studies on Environmental Education (Prosser Bravo & Romo-Medina, 2019), climate literacy (García Vinuesa & Meira Cartea, 2019) or sustainability (Côrtes & Rodrigues, 2016; Hallinger & Chatpinyakoop, 2019).

This academic production occurs mainly in the form of articles (92.02%) published frequently in journals about Environmental Education, although some journals belong to other areas like: Social Sciences, Experimental Sciences, Mathematics and Technology, or Health (nursing or medicine).

The reasons why these journals, which belong to areas of knowledge not traditionally related to Environmental Education, include articles about Environmental Education are diverse; future analyses could study the relationship between Environmental Education and other topics.

Furthermore, the results obtained show that most documents are written in English (96.73%) and they come mainly from countries such as the United States of America, Australia, the United Kingdom and Canada. This reveals Anglo-Saxon's hegemony in discourses in WoS and the smaller presence of other research contexts like Latin America.

Among the most productive countries from Latin America are included three countries: Brazil, Mexico, and Colombia. According to Medina and Páramo (2014), the number of articles about E&E indexed in SSCI database by these three countries is just slightly lower than the number of articles on Environmental Education from Latin America published in journals of education indexed in SCIELO and Redalyc from 2000 to 2013.

Regarding authorship, it is noteworthy that most documents, which were published in the last two decades, are written by two or more authors/researchers, this implies that these articles are the result of a collaborative research process and writing. Many studies consider that articles written by more than one author increase their impact, for example, Borsuk et al. (2009). The results show an increase in the production in WoS and an increasing DC over recent years (0.92 between 2018 and 2019), so this collaboration could be an academic strategy to significantly increase the number of publications. Therefore, it could be considered that the presence of academic networks favoured the publication on WoS.

In addition, the degree of collaboration in E&E is 0.89, it is considerably higher than in other disciplines, for example in Psychology (0.53) (Zafrunnisha & Pullareddy, 2009), Economics (0.58) (Biradar & Tadasad, 2016) or Demography (0.6) (Maz-Machado & Jiménez-Fanjul, 2018). The reasons behind this could be diverse, among them, it could be considered the inter and transdisciplinary approach that is necessary to study and research environmental topics or problems.

Figure 3 shows important publication nodes for example in the United States of America, the United Kingdom, Australia, Canada, and Sweden. Likewise, considering the relation between Spain and some Latin American countries, connections between research contexts can be seen, this might be a strategy to promote studies about countries with less visibility, through international projects and cooperation, and also a way to promote a permanent exchange of information.

An important contribution of this study are the connections among descriptors because they could be useful for

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researchers in the area. In particular, they show how the descriptors connect Environmental Education with other aspects that have traditionally been areas of interest, reflection, and research. Also, this study shows a certain independence of Environmental Education from sustainability or sustainable development, which used to be a dominant line that could sometimes be a bit unifying and restrictive. In other words, this literature review shows studies related to this topic, but it also reveals other theoretical and methodological perspectives that are not necessarily related to sustainability.

On the other hand, the analysis of the clusters allows understanding connections or similarities between the descriptors. Therefore, 11 clusters were generated with a reduced number of elements (between 6 and 9 descriptors), in which coherent relationships (theoretical and practical) were identified. The difference in the size of the clusters is due to the different variables analysed and the similarity in the terms that are part of each one. This allowed inferring the main topics that made the formation of clusters possible (Table 9). This distribution shows that there are some latent issues in all the topics, like environmental attitudes, research in Environmental Education, teaching and learning approaches (from multiple denominations and perspectives). In addition, it shows that Environmental Education is a research field at all educational levels, even, in the training of teachers and of other professionals. Also, Environmental Education binds and integrates different types of knowledge.

This is linked to the co-occurrence of descriptors shown in Figure 6. They reveal important lines of research or problematic dimensions. Firstly, attitudinal aspects are studied from environmental psychology and sociology because there is an interest in describing the main factors in behaviours and attitudes. These issues were also mentioned by Guérin et al. (2001) and Cottrell (2003). Some studies focus on the description of scales (as part of experimental or quasi-experimental quantitative research), which are later used to analyse pro-environmental behaviours, for example Dunlap (2008) or Reyna et al. (2017). Likewise, other studies consider the relevance of learning transdisciplinary knowledge in order to explain relevant environmental situations and problems. This topic was first considered one of the foundations of scientific literacy, and now it has its own conceptual entity, environmental literacy (Lewinsohn et al., 2015; Lloyd-Strovas et al., 2018; Pe'er et al., 2007; Pitman & Daniels, 2016; Roth, 2000).

This bibliometric analysis confirmed that the problems and research topics on Environmental Education are relevant, globally extended, and characterized by a plurality of approaches, both conceptually and methodologically. Therefore, it is needed more knowledge about this field that allows researchers to understand the different behaviour among research lines on Environmental Education, to identify the problems that can be incorporated into this research field and to recognize the natural challenges of researchers when they want to extend their collaboration networks and they want to publish their results in journals included on WoS.

Conclusions and Implications

Since 2000 scientific literature on Environmental Education has experienced an important international increase. Therefore, this shows the relevance of reflection, research, policies and strategies that have been put into practice to transmit to the educational field the need to know and protect the environment. Focusing on the production on E&E, European countries publish 38.1% of the scientific production and the United States of America 33.6%, that is, 71.6% of the production on E&E comes from Europe and the USA.

North American universities are the main producers of international research in Environmental Education, and, on the opposite, Latin American universities produce collectively just 2% of the total documents analysed. The low presence of articles from Latin American countries, Asia or Africa suggests the need for different measures (political, scientific, etc.) in order to favour the democratization of knowledge.

The study that has been presented shows just a sample of the most relevant scientific production in Environmental Education, and it reveals the need for more bibliometric studies in this field in different databases; this will allow collecting more information, in order to contrast and know better the situation of this area of knowledge.

In this sense, this study allows recognizing that Environmental Education is an emerging area which interests researchers from different areas of knowledge and is enriched through collaboration (between research groups, universities, and researchers). In this regard, the study suggests the relevance of the consolidation of research networks in Environmental Education. Also, the study highlights the main topics of research in the field and the latent issues in all the topics, which will help to consolidate the theoretical and methodological identity of this discipline.

Among the limitations of this study is the difficulty of finding all the scientific production on Environmental Education because it is not a clearly delimited discipline in WoS. Due to that fact, it is possible that some related documents included in other WoS categories have not been considered in this analysis. However, the choice of the two categories *Education and Educational Research* and *Education, Scientific Disciplines* guarantees that all documents correspond to the subject under study.

Because of this, the results offer a perspective of the scientific production related to Environmental Education, which can be contrasted with other studies that include the analysis on other databases (like Scopus, ERIC, etc.) or which study other variables or relationships, for example: academic production and the number of inhabitants per country; comparison of productivity between different areas; analysis of different types of documents such as books, book chapters, management reports of environmental corporations and Non-Governmental Organizations. Likewise, future studies can address the specific situation of a country, for example the significant increase in Turkish production in this area. Finally, it would be relevant to carry out a content analysis of the documents, which would expand our knowledge of the data obtained through this bibliometric analysis.

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