A Bibliometrical Analysis of the Articles on Environmental Education Published between 1973 and 2019

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Article Info	Abstract
	The aim of the study is to conduct bibliometrical analysis of the published articles on environmental education. With this aim, 3979 articles published between 1973 and 2019 were reached as a result of scanning Scopus database and they were bibliometrically analyzed so that research tendencies in the last 46 years were determined. The database was scanned using "environment/environmental education" keywords and results regarding the annual distributions of the articles; the journals and the authors with the highest number of related articles; h-index scores of the authors; research collaboration networks; the articles that were cited at the highest rates; the average annual citation scores; the citation burst scores of the authors; the results for word cloud and the conceptual mapping patterns obtained were analyzed. The findings reveal that the issue started to gain popularity among scientific researchers after 2008. The journal publishing the highest number of articles on the topic is found to be *Environmental Education Research* while the researchers with the highest number of published articles belong to Kopnina, H., Bogner, F. X., and Thiengkamol, N. The researchers from Netherlands, Mexico and Israel have the highest rates of research collaborations. The related articles are found to focus mostly on sustainability education, climate change, teacher education, student's or teacher's attitudes toward environment, the level of knowledge and consciousness on environment and environmental issues. The most frequently used concept in the keywords sections of published articles is determined to be "environmental education". The findings of the study are meant to guide researchers planning to conduct further research on the issue.

Introduction

Human beings have been in interaction with the environments since their existence on earth began. While this relationship was at first aimed using the environment for their benefit, it evolved, in time, towards trying to control and dominate it parallel to the advancement in science. As humanbeings started to exploit the environment freely, the destructive effects of these human activities started to cause serious environmental problems. When humanbeings questioned how these destructive results could be overcome, they realized that human activities were responsible for these results and that such activities needed to be controlled and prevented. Scientists working on environment education emphasize the need to raise awareness on environment and environmental issues. Environmental consciousness encompasses individuals' obtaining sufficient information on and acquiring the necessary attitudes and behaviors towards environment (Erten, 2004). In a broader sense, environmental consciousness includes individuals' thoughts, attitudes and behaviors toward environment; their level of awareness on environmental issues; perceptions of and interaction with their environment; ability to understand, know and feel their environment; and their level of knowing and internalizing ethical and scientific norms that regulate the environment (Atasoy, 2006). Thus, the ultimate aim of environmental education is to be able to raise individuals with high consciousness and knowledge levels on environment and environmental issues.

Environmental education is a process where individuals obtain the required values and main concepts related to environment by acquiring the required abilities and attitudes while acknowledging the relationship of humanbeings with their biophysical and cultural environment (IUCN, 1972). For Grodziéska-Jurczak et al. (2006), environmental education is a long-term process where the skills and the behaviors necessary to understand and accept the relationships between people, culture and the natural environment are developed. Environmental education was first mentioned in IUCN Conference held in Paris in 1948 (Palmer, 1998). After

many years of this first mention, in 1972 at Human and Environment Conference organized in Stockholm by United Nation, a general consensus was reached on the approaches towards and the aims of environmental education, and a declaration document was published stating that adults and new generations need to be provided with environmental education (IUCN, 1972). In 1977, Tbilisi Conference was organized by UNESCO – UNEP collaboration. The Proceedings and Implications of this conference contained national and international frameworks for environmental education as well as the content, the aims, and the pedagogical principles of education on environment. In the Proceeding of Tbilisi Conference, the aims of environmental education were presented five main headings: environmental education, consciousness, knowledge, abilities, attitudes, and participation related to environmental education. Accordingly, environmental education aims for all individuals and nations: I) to gain consciousness and awareness on environment and environmental issues; II) to acquire knowledge and experiences on them; III) to develop adopt the appropriate values, awareness and willingness to actively participate in activities for protecting and recovering the environment; IV) to attain the necessary abilities in order to describe, research, and to solve environmental issues; V) to provide opportunities to actively participate in the activities and events that aim to find solutions to environmental issues (ICEE, 1977).

In this respect, there have been plenty of training programs and courses provided to adults and new generations in addition to the social responsibility projects and the scientific research carried out. The aim is to define individuals' environmental consciousness and to help them to acknowledge the existing environmental problems and to guide and equip them with necessary skills and knowledge to solve these problems. Almost every nation has integrated environmental education to their curricula for learners at all ages and has accelerated research on the issue. Grodziéska-Jurczak et al. (2006) conducted a study in 30 pre-school institutions in Poland to determine the learners' (n=674 aged 6) and their parents' (n=686) knowledge and skills levels on environment. Their findings revealed that the majority of the young learners had high levels of environmental consciousness. The participants were found to recognize main concepts related to environment and to distinguish between environmentally-friendly and not friendly behaviors. The findings showed that the participants were environmentally-friendly, acknowledged the value of nature, respected animals and plants, and cared about maintaining cleanliness in their immediate environment. The researchers' state that the parents had significant effects on their children's attitudes and that the attitudes of both the parents and the children were similar regarding using and maintaining natural resources. Liarakou et al. (2011), aimed to explore secondary-school learners' opinions on the causes, the effects, and the potential solutions for global warming. Working with 626 Greek learners (grades 8-11), they found that the learners at 11th grades were more acknowledged on the topics related to global warming such as greenhouse effect or ozone layer depletion compared to younger learners. Also, the learners were found to have clear ideas on the effects of environmental problems while being rather confused about the causes and possible solutions. The researchers concluded that environmental education has a critical role in raising consciousness of learners on environmental issues and in having them actively participate in the related processes. Studies on environmental education have also focused on teachers, who have a significant role in raising consciousness among learners. In their study with 186 teachers in Taiwan, Liu et al. (2015) found that the participant teachers had sufficient levels of knowledge and desired attitudes towards environmental issues; however, they had low levels of participation in related activities. They also indicate that primary school teachers had better performances on the issue compared with high school teachers, which, for them, could only be explained by teacher education policies. Therefore, they suggest that educational programs for professional development of teachers and the policies of school-environment education should be improved. There are also studies conducted to investigate opinions on environmental issues from the perspective of other professions in addition to learners and teachers. For example, Ziadat (2010) conducted a study in Jordan with 2000 participants living in 59 villages and five big cities. Analyzing the collected data based on variables such as gender, age, and educational background, Ziadat (2010) found that women had higher levels of consciousness on environmental issues compared with men and that age and educational background had positive relationship with environmental consciousness. There are numerous studies focusing on investigating environmental consciousness (e.g. Yavetz et al., 2009; Esa, 2010; Yingchao et al., 2011; Arslan et al., 2012; Sammons et al., 2015; Zachariou et al., 2017; Türkoğlu, 2019; Sanchez-Llorens et al., 2019) and almost all of them suggest providing education to increase individuals' consciousness on environment and environmental issues.

There are also studies in which educational programs aiming to improve environmental consciousness of adults and young generations have been developed and the results of such educational programs on environment and environmental issues are presented (Santos et al., 2011; Stanišić & Maksić, 2014; Green & Smorville, 2015; Nxumalo, 2018; Huang et al., 2020; Kuvac & Koc, 2019; Wu et al., 2020; Edsand & Broich, 2020).This line of research aimed to raise awareness on environmental issues, to equip individuals with necessary knowledge and skills to recognise environmental problems and to be part of the solution process. The major problems focused on in these studies are global warming and climate change (Cantell et al., 2019; Ho & Seow, 2015), sustainable development (Kopnina, 2012; Lükö & Kollarikcs, 2013; Halbe et al., 2015), environmental protection (Araghieh

et al., 2012; Heidari & Heidari, 2015), pollution (Aydın, 2015; Radanov, 2016), renewable energy (Taleghani et al., 2010; Mälkki & Alanne, 2017), ecological footprints (Gottlieb et al., 2012; Karaarslan-Semiz & Çakır-Yıldırım, 2018). In these studies, the results of the educational programs given to individuals from different ages and professional groups are discussed while the majority of them included samples of students or teachers. Some of these studies aimed to provide training programs on environment to teachers using different teaching methods, tasks and activities. Glasson et al. (2006) conducted a big scale study in Malawi (a developing country in Africa) and investigated teachers' perspectives and attitudes towards teaching the concepts related to ecological sustainability. They introduced teachers with research based education method in order to overcome ecological deterioration in Malawi. The results of the study indicate that the participant teachers adopted research based education to equip their students with research skills such as investigation, decision-making, and taking responsibility. A similar study was conducted by Shareef (2010) in Maldives. The study revealed that the teachers, who provide environmental education through research based education method could create environments for productive class discussions, easily motivate their learners to become more attentive to environmental issues by learning from different sources. There have been other studies aiming to raise consciousness of students on environmental issues adopting different teaching methods. These studies used student-centered methods such as virtual reality (Horne & Thompson, 2008), educational games (Lin et al., 2011), argumentation (Faize & Akhtar, 2020), collaborative- project based learning (Baser et al., 2017), outdoor education (Higgins & Kirk, 2006). Utilizing various teaching methods, these studies aimed to enable learners and adults to gain environmental literacy and to develop desired attitudes, beliefs, and awareness towards environmental issues (Otto & Pensini, 2017; Erhabor & Don, 2016; McGuire, 2015; Mobley et al., 2010). Today, it is vital that individuals get environmental education in order to become active and conscious agents against increasing environmental problems. Consequently, there is an increase in the number of educational programs, projects and scientific research focusing on environmental issues. The literature in the field reflects the importance attached to the issue. Therefore, it is important for researchers to be given scope for recent research on the topic, to become familiar with and analyse the work of leading researchers.

Researchers can benefit from bibliometrical studies by obtaining accumulated data on the publications related to their research areas (Al et al., 2010). Bibliometrical analysis is an efficient method in identifying the research areas of countries, institutions, and of journals as well as evaluating them in terms of the related area of research (Huang et al., 2006). As bibliometrical research has been attracting researchers, a significant amount of research with bibliometrical analyses have been published on topics such as STEM education, scientific literacy, astronomy, science misconceptions using various programs (e.g., CiteSpace, Vosviewer, R-Studio, etc.) (Effendi et al., 2020; Doğru et al., 2019; Syahmani et al., 2021; Kurtuluş & Tatar, 2021). Doğru et al. (2019) have conducted a bibliometrical analysis of the studies on astronomy education using Citespace. The researchers have analyzed 55 graduate theses published in WoS, Turkish National Center of Higher Education Theses, and ProQuest Dissertations & Theses data bases between 2004 and 2018. Kurtuluş & Tatar (2021) have analyzed the studies on science misconceptions in science education and conducted a bibliometrical analysis of the articles published in Web of Science Core Collection data base using R-Studio program. Analyzing 859 articles published in the last 33 years on the topic, the study has revealed the research tendencies on the topic. Syahmani et al. (2021) have conducted a bibliometrical analysis utilizing Vosviewer program and used "environmental literacy", "STEAM" and "waste management" keywords to scan the articles published in Google Scholar between 1969 and 2020. There are also bibliometrical analysis studies conducted on environmental education on topics such as solid waste, water footprint, carbon education, atmospheric pollution, climate change (Fu et al., 2010; Zhang et al., 2017; Hudha et al., 2020; Li et al., 2017). Doğru et al. (2019) have analyzed 7000 studies published between 2009 and 2018 on "Sustainable Development and Education". Xianchun et al. (2021) have conducted a bibliometrical analysis with 21.225 studies published between 2003 and 2018 using key words related to climate change. Environmental education is among the important topics for researchers. It is quite common to develop and deliver education on environment in order to raise awareness of learners on environment and environmental issues. In this respect, the present study aims to introduce the leading researchers in the field and their work, the journals that publish articles on the issue, and the most frequent keywords used when researching related literature on databases. It is believed that the findings of this study can guide researchers interested in this line of research.

Method

Designed following descriptive research method, the study aims to describe the biometrical characteristics of the articles published in educational journals reached through using "environment/environmental education" keywords in Scopus database. Bibliometrical studies guide journals to improve their publication policies by enabling them to perform internal evaluation. Researchers can also benefit from bibliometrical studies by

obtaining accumulated data on the publications related to their research areas (Al et al., 2010). Bibliometrical analysis is an efficient method in identifying the research areas of countries, institutions, and of journals as well as evaluating them in terms of the related area of research (Huang et al., 2006).

Bibliometric analysis is an analysis method different from meta-analysis. While meta-analysis research aims to arrive at a single general conclusion by bringing the conclusions of different studies together and analyzing them systematically (Dinçer, 2014), bibliometric research is based on analyzing different studies bibliographically. Bibliometric analysis is a method that helps to summarize and to interpret existing information. Literature presents a good number of bibliometric studies (Hernandez-Torrano & Ibrayeva, 2020; Jimenez et al., 2019; Özkaya, 2019; Doğru et al., 2019; Tang et al., 2019; Ye et al., 2019; Jho, 2018; Khodabandelou et al., 2018; Altınpulluk, 2018; Lopes et al., 2017).

Sampling

The data for the study consisted of the articles reached through Scopus database published between 1973 and 2019using "environment/environmental education" keywords. As a result of the initial scanning, the first article on the subject matter was found to be published in 1973; and therefore, 1973 is considered to be the starting date for this line of research. As 2020 has not finished yet, the articles published in 2020 so far were also excluded from the sample of the study since they could affect the results of the analyses. Science Citation Index (SCI), Social Science Citation Index (SSCI) and Art & Humanities Citation Index (A&HCI) international citation indexes are regarded to be the most important sources in bibliometrical analyses. Since these indexes could be accessed through Scopus database (Güzeller & Çeliker, 2017), which is compatible with the bibliometrical analysis system run through R-Studio program, Scopus was chosen as the database to carry out the present research.

It should be noted that the sampling of the study has some limitations. Firstly, the sample did not involve of all the publications on environmental education in the related literature. All of the published articles in Scopus database emerging as a result of the search with "environment/environmental education" key words were included in the analyses of the study. However, the scope of the study is limited to related published work only in article format and does not cover conference papers, reviews, editorials, notes, letters, short surveys, book chapters, books and reports published on the topic. It is also important to note the limitation related to subject area. Subject areas of biological sciences, earth and planetary sciences, physic and astronomy and chemistry were counted in, as they comprise fields of environmental science, social sciences and science. In addition, year of publication was also set to be another limitation for the reasons mentioned earlier. There was no limitation regarding the publication language, and thus, articles published in any language were included in the analyses.

Data Collection

As a result of the scanning conducted in Scopus, 5547 publications in total were reached. For the aim of the study, search limitations such as publication type (i.e., journal article) and time period were set and 3979 articles were obtained and included in the analyses. The analyses results for this sample of 3979 articles revealed the findings related to the annual distributions of the articles; the average citation scores; the journals and the authors with the highest number of related articles; the citation burst scores and h-index of the authors; the scientific productivity of the countries of the authors; the articles that were cited at the highest rates; collaboration networks; and their patterns that were obtained through text mining methods of word cloud and conceptual structure mapping.

Data Analysis

The sample of the articles was analyzed using R-Studio program accessed at https://cran.r-project.org/, which is the official storage website of many bibliometric analysis packages. For bibliometrical analyses in quantitative research, these package programs are considered to be effective (Aria & Cuccurullo, 2017). The rationale behind chosing R program for the bibliometric analyses conducted is that it provides more variety of results with enriched details. After forming the data file for the study through Scopus database based on the criteria identified for the research, the first step was to select "All" in the file. Then, the options "export", "bibtex", "citation information, bibliographical information, abstract & keywords, funding details, other information" were selected and finally "exported. Since the data file after the selection had 3979 articles, the articles were

saved in two separate files as the system allows downloading maximum 2000 articles at a time. Then, these two files were combined before downloading "bibliometrix" package in R program and activating it for the analyses. Next, R-Studio program directed to bibliometric analysis page through a web address. At this step, the "bibtex" file was saved into data segment and the analyses of the study were conducted. Figure 1 displays the flow of the actions taken during the analysis process.
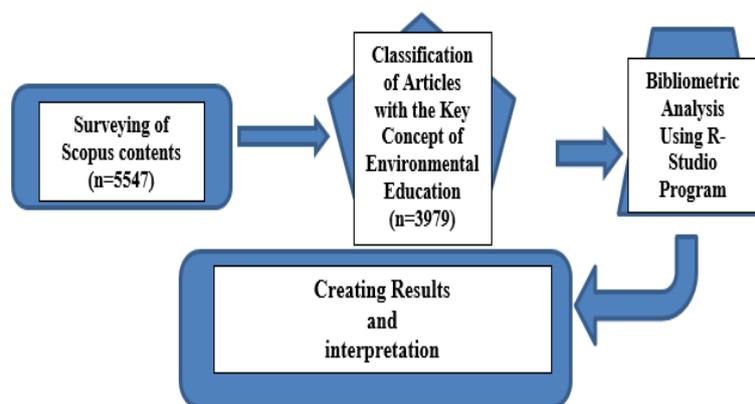

Figure 1. Actions conducted during data analysis

Bibliometrical laws and models are the rules established based on various statistical calculations and distributions in order to evaluate research processes of authors. These laws are generally simple mathematical and statistical functions that analyze the correlation of a variable with another variable (Karaboğa, 2019). In bibliometrical science, there are five laws to determine the bibliometrical productivity. These are Lotka law, Bradford law, Zipf law, Price law and Pareto law. In the present study, Bradford law was evaluated in terms of compatibility. The reason for excluding the evaluation of the other laws is that all laws have the same focus, and also, that R-Studio program provides statistical information with visuals on Bradford law. Bradford law, which is also referred to as the distribution law, is considered in the study. In one of his studies in the field of geophysics, Bradford reached to 326 journals in total. Bradford tried to explain the correlation for his study by using 1:n:n2 equation. The first group includes the smallest number of related journals but with the most important ones that are considered "core sources". While the second group covers a higher number of journals, the third group includes the journals with the lowest impact rates (Bookstein, 1980). In our study, the first group consisted of 21 journals considered to be core sources with 1314 articles on environment/environmental education. The second group had 140 journals with 1333 articles whereas the third group included 827 journals with 1323 articles in total. It is believed that the study conducted by scanning with the key concept of "environment/environmental education" complies with Bradford law.

Results

As a result of the bibliometrical analysis conducted on environment education, 3979 articles published in the span of 46 years were obtained. The distribution of the articles by time periods is shown in Table 1.

Table 1.The distribution of the articles by time periods

Year	Number of Articles (f)	Percentage (%)
1973-1978	5	0.13
1979-1984	31	0.78
1985-1990	54	1.36
1991-1996	154	3.89
1997-2002	306	7.69
2003-2008	499	12.56
2009-2014	1437	36.14
2015-2019	1490	37.45

Table 1 indicates that the relevant articles started to be published in 1973 and the highest frequency was reached between 2015 and 2019 (f=1490). The articles on the topic published after 2008 make up for 73.59% of the total articles. Graph 1 displays the top 20 journals in the rank of the publications.
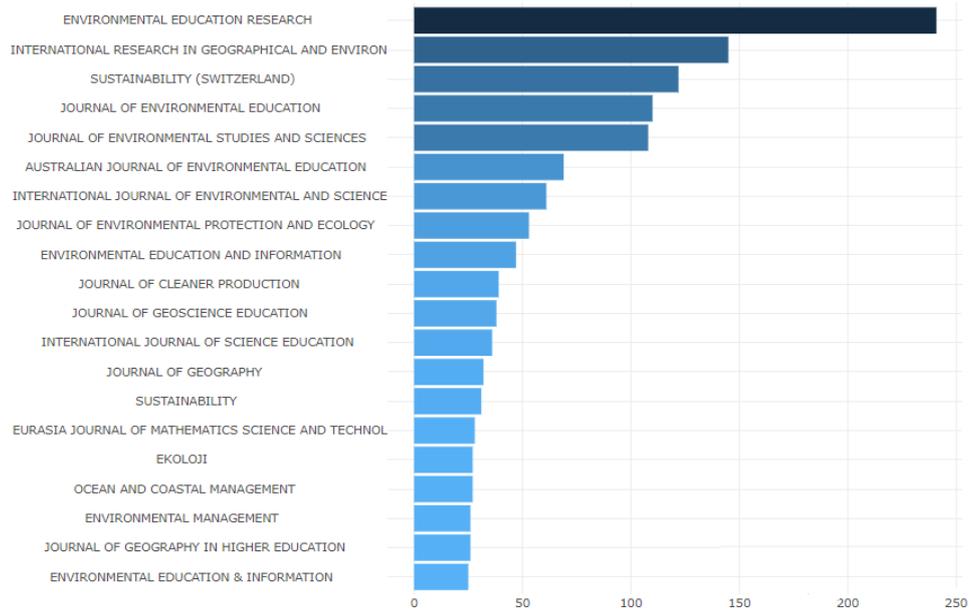
Graph 1.Journals with the highest number of published articles on environment/environmental education science misconception

As a result of the scanning conducted using "environment/environmental education" keywords, the obtained articles were found to have been published in 988 different journals. The highest numbers of the accessed articles were published in *Environmental Education Research* (f = 241), *International Research in Geographical and Environmental Education* (f = 145) and *Sustainability (Switzerland)* (f = 122). Table 2 presents authors' number of articles on the subject matter and the information regarding the h index scores.

Table 2. Number of articles and h-index information of the authors based on the topic

Author	h-index	Total Citations	Number of Article	Start Date for Publishing
Kopnina H.	11	445	18	2011
Bogner F. X.	10	417	15	1998
Krasny M. E.	10	334	12	2009
Boyes E.	8	230	13	1994
Stanisstreet M.	8	230	13	1994
Ballantyne R.	8	406	11	1995
Jacobson S.K.	8	234	10	1991
Jickling B.	7	422	11	1996
Ardoin N. M.	6	178	10	2008
Ertepinar H.	6	186	8	2006
Tal T.	6	78	8	2010
Powell R.B.	6	286	7	2008
Lundholm C.	6	135	6	2008
Thiengkamol N.	5	80	15	2011
Goldman D.	5	206	8	2006
Gough A.	5	58	8	2004
Skanavis C.	5	43	7	2004
Monroe M. C.	5	286	6	2010
Stern M. J.	5	246	6	2008
Tilbury D.	5	103	6	1994

When the authors who published the most articles on the subject are examined, it could be seen that the authors with the highest number of articles are Helen Kopnina (f = 18), who is from The Hague University of Applied Sciences in Holland, Franz X. Bogner (f = 15), who is from University of Bayreuth in Germany, and Nongnapas Thiengkamol (f = 15), who is from Mahasarakham University in Thailand. It has been found that 8810 articles in total have been published on the topic by one author or in collaboration of multiple authors. The number of published articles per author 0.451, while the number of authors per article is 2.22. The top 20 authors

depending on their h-index information are in Table 2. h-index enables evaluations on the quality of published work by the researchers. The h-index number of a researcher is determined by the number and the distribution of the citations to their published articles. As Hirsch (2005) explains, if a researcher has h number of articles each of which receive h number of citations; and if his or her other articles have received h number of citations, then this researcher's index value is accepted to be According to Table 2, the researcher with the earliest published article on the topic started in 1991, and the latest researcher started the first publication on the topic in 2011. The researchers in listed in Table 2 mostly started publishing their articles before 2000, except the two researchers in the first eight. Table 3 displays the countries of the corresponding authors, the number of articles, and SCP and MCP values.

Table 3.The number of articles per country and SCP and MCP values

Country	Number of Article	Frequency	SCP	MCP	MCP Ratio
USA	769	0.273958	703	66	0.0858
United Kingdom	205	0.073032	183	22	0.1073
Brazil	182	0.064838	164	18	0.0989
Australia	166	0.059138	140	26	0.1566
Canada	120	0.04275	101	19	0.1583
Spain	117	0.041682	99	18	0.1538
Germany	96	0.0342	76	20	0.2083
Turkey	93	0.033131	82	11	0.1183
Greece	65	0.023156	57	8	0.1231
Japan	57	0.020306	50	7	0.1228
China	51	0.018169	41	10	0.1961
South Africa	47	0.016744	40	7	0.1489
Italy	42	0.014963	35	7	0.1667
Netherlands	38	0.013538	28	10	0.2632
Taiwan	36	0.012825	31	5	0.1389
Mexico	35	0.012469	26	9	0.2571
New Zealand	34	0.012113	30	4	0.1176
Thailand	34	0.012113	31	3	0.0882
Israel	32	0.0114	25	7	0.2188
Portugal	32	0.0114	26	6	0.1875

As can be seen in Table 3, the top three countries are the USA (SCP: 703, MCP:66) with 769 articles in total, United Kingdom (SCP:183, MCP:22) with 205 articles, and Brazil (SCP: 164, MCP: 18) with 182 articles. Out of 3979 published articles, 1270 of them had a single author whereas the rest were written by multiple researchers' collaboration. Therefore, it is seen that the majority of the articles were written in collaboration of the researchers. The Single Country Publications (SCP) values refers to the number of published articles by the researchers from the same country and the Multiple Country Publications (MCP) values represent the number of the articles by the researchers from different countries. While the USA ranks the first among the countries with the highest number of articles on the topic, it has one of the lowest values of MCP among 20 countries. In other words, the researchers in the USA conducted their research in collaboration with the researchers in the same country. Although Netherlands ranks as the 14th among the 20 countries in terms of the number of published articles, it has the highest MCP value. This indicates that the researchers in Netherlands, Mexico and Israel are more open to international collaborative studies. Table 4 displays the researchers and the collaboration clusters.

Table 4. Co-citation networks author-cluster-centrality values

Author	Cluster	Author	Cluster	Author	Cluster
Kim M.	1	Ardoin N.M.	4	Davies K.	8
Skamp K.	1	Uak M.	5	Bhattacharyya R.	8
Boyes E.	1	Pruneau D.	6	Kugan R.	8
Stanisstreet M.	1	Thiengkamol N.	7	Luckhurst D.A.	8
Taylor N.	1	Fullen M.A.	8	Chan K.	8
Ambusaidi A.	1	Subedi M.	8	Black A.W.	8
Bogner F.X.	2	Booth C.A.	8	Townrow D.	8
Groffman P.M.	3	Sarsby R.W.	8	James T.	8
				Poesen J.	8

According to Table 4, it can be stated that the authors in the same cluster publish articles on similar topics in collaboration with other authors. For example, when the authors in the eighth cluster are analyzed, it can be seen that their research areas are similar and that they have co-authored many publications. Graph 2 shows the collaboration network of universities.
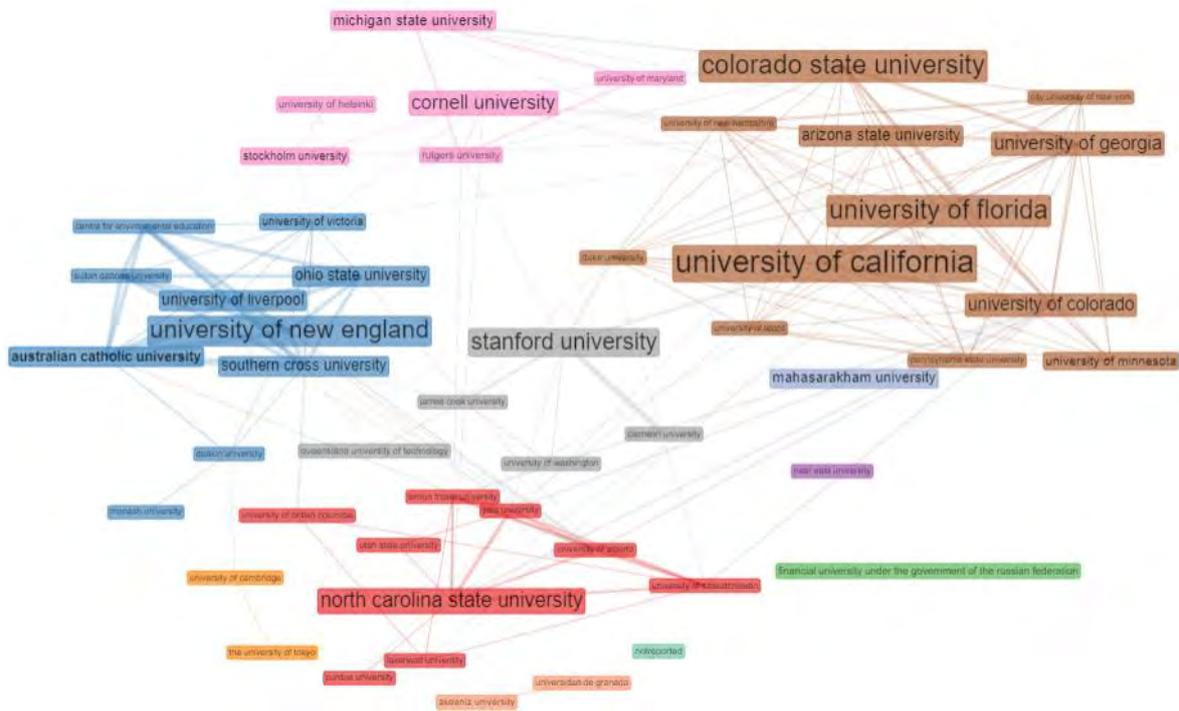
Graph 2. Collaboration network of universities based on research areas

As the results displayed in Graph 2 indicate, collaboration groups form mainly five clusters. The highest collaboration rates among the institutions are found in University of California, University of Florida, University of England, North Carolina State University, Stanford University and Cornell University. Researchers tend to cite the previous work conducted on the same topic. Graph 3 shows the articles with the highest citation rates.

Graph 3. The articles with the highest citation rates

Analyzing Graph 3, it can be seen that among the published articles on "environment/environmental education" key concepts, the highest citation scores belong to Brulle et al. (2012) with 422 citations in total, followed by Whitmarsh (2011) with 376 citations and Stringer et al. (2006) with 357 citations. Graph 4 displays citation burst scores of the published articles on the topic.

Graph 4.Authors' citation burst scores

Considering citation burst scores of the authors, F. X. Bogner (24.50) had the highest score between 1998 and 2018. However, this does not indicate that Bogner is the author with the highest number of citations; rather, it implies that Bogner had the highest number of citations when the citation burst occurred. M.Varela-Losado and P. Vega-Marcote have been among the frequently cited authors in recent years as they were cited between 2013 and 2019. F.X. Bogner (24.50), R. Ballantyne (20.30), B. Jickling (19.38) and H. Kopnina (18.85) are the leading researchers that have been working on the topic for many years. Figure 2 presents the Word cloud for the most frequently used keywords in the articles published on environment and environmental education.

Figure 2.Word clouds of the keywords

As one of the data mining methods, word clouds method enables researchers to reveal the most frequently used words in a paragraph or a text. The most frequently used word in the topic is shown in the center. The sizes of the words and their relative closeness to the central word reflect how frequently have been used. The further the word is located from the center and the smaller the size gets, the less commonly the word is used. The keywords of the articles were scanned with the word clouds. Figure 2 indicates that the keywords with the highest frequencies are education (f=490), student (f=465), sustainable development (f=346), environmental protection (f=322), and teaching (f=313).

One of the important analyses conducted within biometrical analyses is conceptual structure mapping of the publications. As a result of the factor analysis of the concepts, the dynamics of the conceptual structure and the conceptual milestones in the related literature could be revealed by analyzing the keywords used by the authors. Graph 5 presents conceptual structure mapping on the topic.
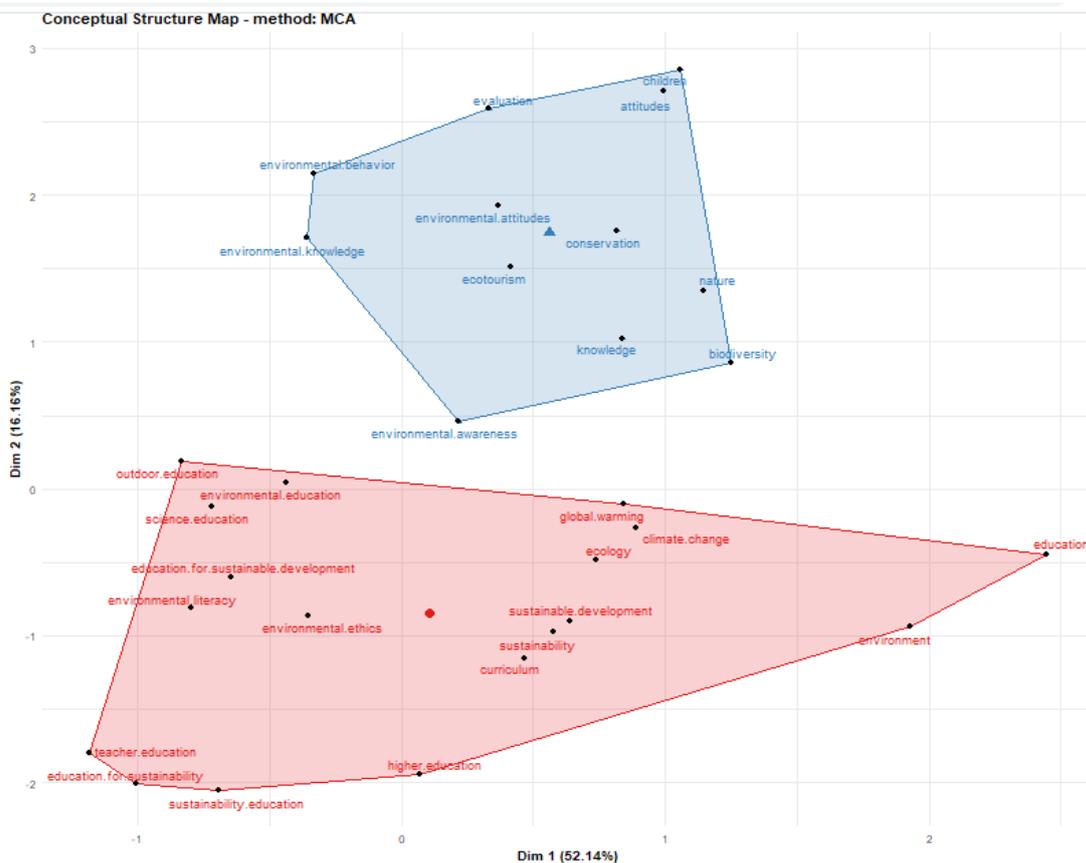
Graph 5. Conceptual structure mapping

As a result of the factor analysis, the clusters displayed in Graph 5 were formed. The bigger group represented in red includes articles related to educational topics and concepts focusing on issues such as teacher education, sustainability education, science education, climate change, and ecology. The blue cluster on the top is found to cover learning areas such as environmental knowledge, attitudes or awareness.

Conclusion and Discussion

The study scanned the articles accessed using "environment/environmental education" keywords in Scopus database, which provides access to international publications and citations. The scanning resulted in 5547 publications in total. Having set limitations such as publication type and date, the sample consisted of 3979 articles, which were then analyzed bibliometrically using R-Studio program. As a result of the analyses carried out, findings regarding the annual distributions of the articles; the average citation scores; the journals that published the highest number of related articles; the authors that had published the highest number of related articles and their h-index information; the citation burst scores of the authors; the scientific productivity of the

countries of the authors; the articles that were cited at the highest rates; collaboration networks; and their patterns that were obtained through text mining methods of Word cloud and conceptual structure maps.

The findings show that the oldest article on the topic was published in 1973 in "*Journal of the Air Pollution Control Association*" by L.D. Kornreich et al. and was titled "*University Consortia: A Unique Approach to Environmental Education and Research*". The number of the published articles on the topic was found to increase after 2008 and reached its peak between 2015 and 2019 (f=331). In the 21st century, sensitivity towards environmental issues is observed to increase while efforts to provide effective approaches and methods for these problems started to gain more importance. The need to acknowledge environmental problems and finding measures against these problems have led scientists to focus more on the topic. The annual article publication on the topic is found to be 14.39%. Considering annual growth rate, it is expected that there will be an increase in the number of articles on the topic in 2020. It is also estimated that environment and environmental education will be the most studied topic among the published articles in 2020.

The articles on the subject matter have been published in 988 different journals. This suggests that a good number of journals place importance to the topic. The journal having published the highest number of articles on the subject matter is determined to be "*Environmental Education Research*" (f=241). The other journals on the list are prestigious journals in the field. It has been also identified that 8810 authors in total have worked on the subject matter either individually or in collaboration with other researchers. The author with the highest number of articles on the topic and the highest h-index score is identified to be H. Kopnina. According to the data in Scopus, the researcher has 18 published articles on the topic and has received 445 citations. These articles are usually on sustainability. The second author on the list is F.X. Bogner with 15 articles, mostly focusing on sustainable development and environmental education. He is found to have received 417 citations in total with 10 h-index score. The researchers who started to publish articles on the subject matter in earlier dates are more likely to have further articles on the topic as, compared to the authors who started to focus on the topic recently, they are more likely to work on research projects with young researchers they may have trained on the topic or with the research groups they have worked with previously. Yet, the authors who have recently started to produce articles on the topic are also expected to have higher rates of citations in time and attain higher h-index scores.

The majority of the published articles on the subject matter are seen to be by researchers from America, the UK, and Brazil. The researchers from Netherlands, Mexico and Israel are shown to be the most collaborative researchers. Researchers from Mexico are found to have worked in collaboration with researchers from America, Canada, the UK, Australia, Italy, and Spain (e.g., Ruiz-Mallen et al., 2010; Mercado-Domenech, et al., 2017). The researchers from Israel, on the other hand, have worked with mostly American colleagues (e.g., Tal & Alkaher, 2010; Brenner et al., 2005). When analyzing collaboration at university level, it is revealed that universities that are more open in terms of location are the ones that have the highest numbers of published articles on the topic.

The highest annual citation rate is found to belong to 2010. According to citation burst scores, F.X. Bogner is shown to receive the highest number of citations for his three articles published in 2013. These articles are "Promoting connectedness with nature through environmental education" (Liefländer et al., 2013) and "Climate change education: quantitatively assessing the impact of a botanical garden as an informal learning environment" published in "*Environmental Education Research*" (Sellmann & Bogner, 2013a); and "Effects of a 1-day environmental education intervention on environmental attitudes and connectedness with nature" published in "*European Journal of Psychology of Education*" (Sellmann & Bogner, 2013b).

Having a citation burst for a publication does not mean to have the highest number of citations, rather this is determined by the density of citations in a specific period. For example, citation burst scores of the scanned 3979 articles in Scopus database are determined based on the citation numbers received in a specific period. As one of the leading researchers on the subject matter, H. Kopnina is seen to have started to publish articles on the subject matter later compared to the other leading authors. Her highest citation burst score belongs to her article titled "Education for sustainable development (ESD): the turn away from 'environment' in environmental education?" published in "*Environmental Education Research*" in 2012. The second and third highest citation burst scores belong to the article titled "Visitors' learning for environmental sustainability: Testing short- and long-term impacts of wildlife tourism experiences using structural equation modelling" published in "*Tourism Management*" (Ballantyne et al., 2011) and "Globalization and environmental education: looking beyond sustainable development" published in "*Journal of Curriculum Studies*" (Jickling & Wals, 2018). However, the citation burst scores of these three researchers are still lower than Bogner's score. The researchers with highest citation scores are found to be from America. The highest number of received citation is found to belong to

Robert J. Brulle, Jason Carmichael and J. Craig Jenkins for their article titled "Shifting public opinion on climate change: an empirical assessment of factors influencing concern over climate change in the U.S., 2002–2010" published in "*Climatic Change*" in 2012.

According to the findings obtained through text mining analyses, the most frequently used keywords by the authors when using keywords for scanning and when writing abstract sections of their articles are "education" and "environmental education". "Sustainability" and "sustainable development" concepts are also found to be frequently used. Another significant finding of Word cloud analyse is that America and China, having high numbers of published articles on the topic, appears in keywords section. This is due to the high numbers of published articles reporting the studies conducted in their specific contexts. These researchers are found to refer to their countries in keywords and abstract sections (e.g., Mitchell, 2009; Chen & Li, 2019). As a result of conceptual structure mapping analysis, two main groups are identified based on the studied topics. One of these two groups is found to focus more on education, sustainability, and climate change topics (e.g., Jickling & Wals, 2008; Whitmarsh, 2011; Pooley & O'Connor, 2000) while the other group consisted of articles related to learning outcomes such as attitudes towards environment, environmental awareness, or biodiversity (e.g., Littledyke, 2008; Özden, 2008; Cambray, 2003; Hostetler et al., 2011).

Suggestions for Future Studies

The overall results of this study clearly show that there is an increasing interest in environmental education. The worsening environmental issues today require raising conscious generations equipped with necessary knowledge and skills to overcome these problems. It is vital to support and to keep up to date with the research on environmental issues in order to be able to educate new generations and improve national and international policies. Several suggestions for the researchers could be made based on the findings of the study.

It has been identified that the majority of the research on environmental education has been conducted with the participation of learners. Further research could be conducted with the participation of different groups of samples considering variables such as profession, educational backgrounds or region of residence. However, it is found that most of the published research is about the outcomes of educational or training programs provided to help individuals become aware of environmental issues and be part of the solution process. Global warming, and climate change, sustainable development, biodiversity, pollution and energy consumption are among these serious environmental problems. It can be suggested that researchers determine their research focus considering these issues. At the same time, it is suggested that longitudinal studies be conducted in order to raise consciousness of individuals on environmental issues and to track retention level of such a consciousness. Bibliometrical analyses could guide researchers in determining research topics and conducting research. Therefore, researchers could run bibliometrical analyses using the keywords related to research areas. This will enable them to gather the leading researchers and read their research. They can also identify the journals that publish articles in these research topics and send their research for publication. Finally, Scopus database was used in the present study. Similar studies could be conducted using databases such as, Web of Science Core Collection or Proquest. In addition to articles, research published as theses, books, or conference proceedings could be included to the sample for the analysis. Different limitations could be set to analyse articles published in a specific range of journals or years.

Scientific Ethics Declaration

The authors declare that the scientific ethical and legal responsibility of this article published in JESEH journal belongs to the authors.

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