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Analyzing The Evolution of Environmental Literacy Research in 21st Education: A Bibliometric Analysis from 2001 to 2022

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Abstrak

Pada abad ke-21 literasi lingkungan menjadi topik yang krusial untuk dikaji dan ditanamkan kepada setiap individu ditengah problematika lingkungan yang semakin nyata. Oleh karenanya, riset ini ditujukan untuk menganalisis perkembangan topik literasi lingkungan dalam konteks pendidikan dalam rentang waktu 2001-2022 agar diketahui perkembangan dan potensi riset tersebut di masa mendatang. Penelitian ini menggunakan metode bibliometric analysis dengan data yang bersumber dari sopus. Dari total 518 artikel yang diperoleh, hanya 386 yang memenuhi kriteria untuk dilanjutkan pada tahap analisis kinerja dan pemetaan ilmiah dengan perangkat lunak Publish or Perish dan VoSviewer. Temuan penelitian menunjukan bahwa perkembangan literasi lingkungan dalam konteks pendidikan mengalami peningkatan baik secara produktifitas publikasi ataupun jumlah kutipannya. Amerika Serikat, Indonesia, dan Turkey menjadi negara yang paling berkontribusi. Meskipun secara keseluruhan isu yang diangkat masih didominasi environmental literacy dan environmental education, nyatanya dalam tiga tahun terakhir telah terjadi pergeseran. Riset ini mengindikasikan bahwa topik literasi lingkungan dalam konteks pendidikan masih menjadi topik yang menarik dan bermanfaat untnuk tetap dilakukan di masa mendatang. Temuan tersebut berimplikasi terhadap adanya urgensi untuk memperluas cakupan riset literasi lingkungan dalam konteks pendidikan terhadap isu-isu yang masih terbatas. Dengan demikian, penelitian ini dapat memberikan panduan bagi para peneliti dalam menetapkan arah penelitian yang baru, memperkaya pengetahuan yang ada, dan memberikan kontribusi yang lebih substansial bagi pengembangan literasi lingkungan dalam konteks pendidikan pada abad ke-21.

Kata kunci: *Literasi Lingkungan, Masalah Lingkungan, Analisis Bibliometrik, Abad 21*

Abstract

Environmental literacy has emerged as a paramount subject to be studied and ingrained in individuals in the 21st century due to the rising concerns over environmental problems. Hence, this research is aimed at analyzing the development of environmental literacy topics in the educational context in the 2001-2022 period to understand the development and potential of this research in the future. This study used the bibliometric analysis method with data sourced from Scopus. Out of 518 articles obtained, only 386 met the criteria for performance analysis and scientific mapping using Publish or Perish and VoSViewer software. The result showed that the development of environmental literacy in the educational context has increased both in terms of publication productivity and the number of citations. The United States, Indonesia, and Turkey contributed the most. Although overall the issues raised are still dominated by environmental literacy and environmental education, there has been a shift in the last three years. The result of this study indicates that the subject of environmental literacy within educational settings remains both compelling and pertinent for future exploration. These findings have implications for the urgency of expanding the scope of environmental literacy research in the educational context to issues that are still limited. Consequently, this study can serve as a roadmap for researchers to establish new research directions, enrich existing knowledge, and make a more substantial contribution to developing environmental literacy in educational contexts in the 21st century.

Keywords: Environmental Literacy, Environmental Problem, Bibliometric Analysis, 21st Century

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1. INTRODUCTION

The active involvement of the community as responsible citizens who not only demand access to good environmental conditions but also take concrete steps to achieve environmental sustainability is crucial. This stems from the reality that most of the damage to the earth's ecosystem cannot be separated from human activities, and this can threaten the

future continuity of humanity. This point of view is backed by recent research conducted by previous studies that ecosystem damage is inseparable from human indiscretion in behaving toward the environment (Jain et al., 2022; Wang et al., 2022; Zandalinas et al., 2021). In line with other study emphasizes that the biggest challenge facing humans in the 21st century is sustainable environmental preservation (Bandura, 2016). It can be asserted that every person in society has a moral obligation to protect the environment and maintain a sustainable ecosystem for future generations. This is because the current state of the environment is directly linked to human actions. Therefore, society must have a good understanding of environmental issues, which highlights the importance of environmental literacy.

Recent studies revealed that increasing environmental literacy among the community can be an effective solution to addressing environmental problems as it will foster community responsibility, awareness, and knowledge of environmental issues. This can help individuals make the right decisions in dealing with environmental problems (Kholifaturrohmah et al., 2023; Putri et al., 2023; Yusliani & Desnita, 2021). Good environmental literacy is not just formed in individuals but is the result of the educational process, especially environmental education (Ruan, 2022; Wajdi et al., 2022; Yuan et al., 2020). Thus, education plays a vital role in increasing community environmental literacy to contribute to realizing a pattern of people who have concern for environmental sustainability, know various threatening environmental issues, and can become environmental problem solvers. In the long term, it can contribute to the formation of a pattern of society that has a moral responsibility towards environmental sustainability.

Studies related to the concept of environmental literacy in education are not new. In studies, the educational process to foster environmental literacy can be carried out in various ways, such as social studies learning (Bayram, 2021; Byker & Vainer, 2020; Topkaya & Doğan, 2019), biology learning (Al-Muhdhar et al., 2021; Angreani et al., 2022; Halim et al., 2021) utilizing local wisdom (Ilhami et al., 2019; Muflihaini et al., 2020; Sari et al., 2020; Septiani et al., 2020), using comic media (Abidin et al., 2023; Wajdi et al., 2022), and using problem-based learning models (Febriasari & Supriatna, 2017; Fenny et al., 2019; Suryawati et al., 2020). Many studies have focused on environmental literacy in the educational context, but they have not comprehensively analysed its development in the 21st century and presented it visually through bibliometric analysis.

Such studies are important to know the progress of the study that has been carried out as stated by previous study bibliometric analysis is an accurate and widely used method for exploring and analyzing large amounts of scientific data (Donthu et al., 2021; Zyoud et al., 2023). The results of the study can be used as a basis for determining publications that are popular and significant in a field. Previous bibliometric analyses have been conducted by previous studies to explore topics related to environmental literacy (Afandi et al., 2023; Hudha et al., 2023). However, these studies had limited scope as they only analyzed data from the last decade (2010-2020), and did not exclusively focus on environmental literacy in the context of education. The novelty of this research fill the research gap, the present study aims to analyze the development of publications, dominant topics, and future research opportunities related to environmental literacy within the context of education in the 21st century or the last two decades (2001-2022).

2. METHODS

This study employs the bibliometric analysis procedure as it is suitable for examining and evaluating specific research (McNicholas et al., 2022). In line with that, Donthu et al. (2021) previous study explained that the functions of bibliometric analysis are as follows: (1) obtaining a comprehensive and rapid overview; (2) identifying potential knowledge

gaps; (3) generating new ideas for research; and (4) positioning existing contributions (Donthu et al., 2021). Therefore, this method is suitable for obtaining a structured and scientific understanding of the development of environmental literacy research in the field of education, as well as for cultivating innovation and meaningful contributions. The stages conducted in this study refer to the research of (Fahimnia et al., 2015; Setyaningsih et al., 2018) as presented in Figure 1.

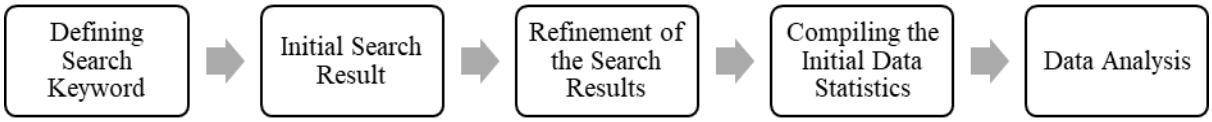

Figure 1. The Stages of the Research

The literature search process was conducted using the Scopus database on March 28, 2023. The query string used in this research is as follows TITLE-ABS-KEY ("environmental literacy" AND "education" OR "Learning"). The initial search process found 518 documents published between 1971-2022. The search results will be compiled in a research information systems (RIS) format, which is intended to include all important article information such as title, author and affiliation, abstract, keywords, and references. From the initial search results, a selection process was conducted as presented in Table 1, so that in the end only 386 data articles were extracted.

Table 1. The Process of Document Selection

No	Criteria	Number of documents	The total of remaining documents (n=518)
1	The documents published between 2001 and 2022	45	473
2	The documents are not in English.	15	458
3	The types of documents are not articles or proceedings	72	386

The data that has been collected is stored in RIS format and presented using Publish or Perish software. In the first stages, the components of the journal article will be checked, such as the year of publication, volume, number, pages, and so on. If there is incomplete data, the necessary information will be added. This study applies performance analysis and scientific mapping to analyze relevant data (Donthu et al., 2021; Zhang et al., 2021). In the performance analysis, the Publish or Perish software is used to conduct various types of analysis, such as descriptive analysis, publication and citation trends, author and publication profiles, and journal-related analysis. Additionally, the VoSviewer software is used to visualize scientific mapping..

3. RESULTS AND DISCUSSION

Results

Trends of Environmental Literacy Publications

This section presents a descriptive analysis of some relevant articles and the results are presented in Table 2.

Table 2. Result of Descriptive Analysis

No	Description	Result
1	Period	2001-2022
2	Total Publication	386
3	Total Citation	5523
4	Citation/Year	251.05
5	Citation/Paper	14.31
6	Author/Paper	3.11
7	h-Index	39
8	g-Index	60

Table 2 shows that since the beginning of the 21st century, especially in the period 2001-2022, a total of 386 Scopus-indexed articles have been published. These articles resulted in a total of 5523 citations, which means that on average there are 251 citations each year with a citation-to-article ratio of 14.31. This indicates that an average of 14 researchers refer to each published article. Further information regarding the development of environmental literacy research in the context of education in the 21st century can be seen in Figure 2.

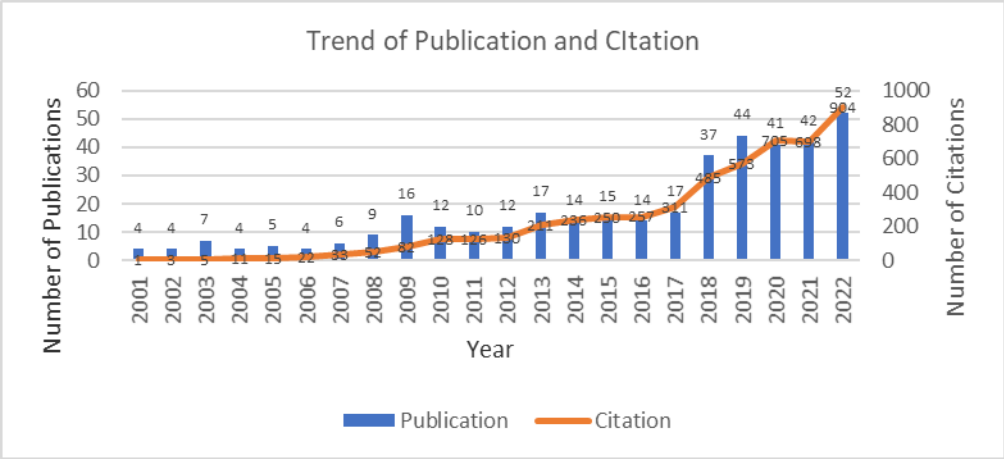

Figure 2. Trend of Publication and Citation

Base on Figure 2, in the first year, there were only four publications. Until the end of the first decade of the 21st century, research experienced fluctuations and publications tended to be low. Even in the middle of the second decade, there was no significant change. In 2018, publications doubled compared to the previous year. Overall, environmental literacy research in the context of education in the 21st century has increased more than 10 times, from 4 articles in 2001 to 52 articles in 2022.

Indeed, the trend of citations to environmental literacy articles in the educational context increased but it was relatively slow. There was a significant increase in citations in 2018 compared to the previous year, which was in line with the increased productivity of article publications. In 2022, the number of citations reached 904 times with a total of 52 publications. In other words, each article was cited an average of 17 times in 2022. Environmental literacy research in the educational context shows positive growth both in the context of publication productivity and the quality of its publications which is reflected in the increase in citations in the last two decades. Figure 3 shows the distribution of countries that have actively contributed to the development of environmental literacy publications in Scopus-indexed journals in the last 2 decades.

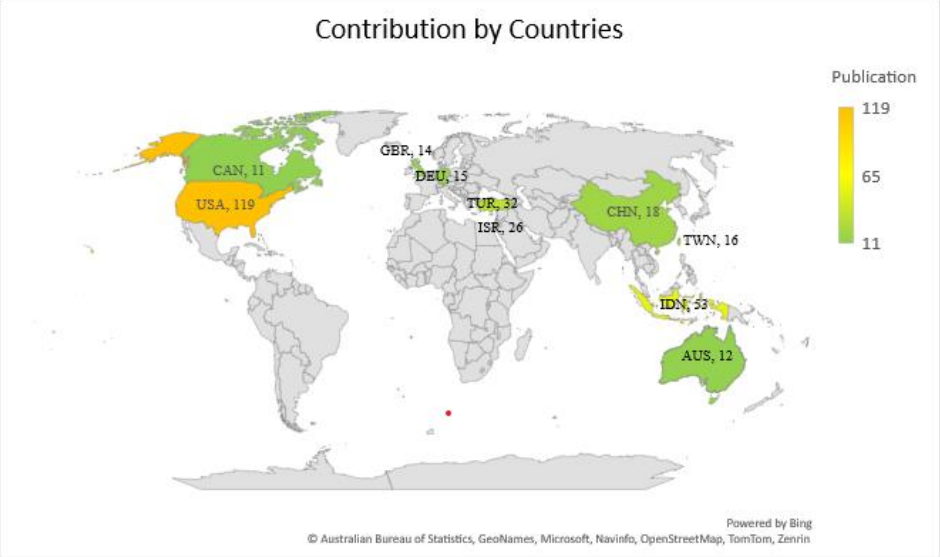

Figure 3. Contribution by Countries

Base on Figure 3, the United States has the highest publication with 119 publications (30.82%), followed by Indonesia with 53 publications (13.73%), Turkey with 32 publications (8.29%), and Israel with 26 publications (6.73%). Besides, China, Taiwan, Germany, the United Kingdom, Australia, and Canada have publications of less than 20 articles. Although the results of the analysis show that the United States dominated the publication, the most productive and influential researchers come from Beit Berl Academic College in Israel, namely Daphne Goldman. Top five authors by publication and citation is show in Table 3.

Table 3. Top Five Authors by Publication and Citation

No	Author	Total Publication	Total Citation	Affiliation
1	Goldman, D.	10	564	Beit Berl Academic College
2	Yavetz, B.	6	457	Kibbutzim College of Education
3	Powell, R.B.	6	51	Clemson University
4	Stern, M.J.	6	51	Virginia Polytechnic Institute and State University
5	Kroufek, R.	6	5	Jan Evangelista Purkyne University

Base on Table 3, Goldman is the most productive researcher with 10 publications and even he is the most influential researcher with 564 citations meaning that an average of 1 article is cited 56 times. One of the most influential articles written by Goldman is Environmental Literacy in Teacher Training: Attitudes, Knowledge, and Environmental Behavior of Beginning Students which was written in collaboration with Sara Pe'er and Bela Yavetz with 183 citations. The other four researchers are also productive in conducting research in this field, namely Yavetz, Powell, Stern, and Kroufek. They have the same number of publications, namely 6 articles. However, compared to the others, articles written by Yavetz have a higher number of citations, namely 457 times. This result indicates the significant contribution of the five researchers in enriching environmental literacy literature in the educational context.

Trends of Environmental Literacy Research Topics in Educational Contexts

In this study, co-occurrence analysis was conducted based on the publication title and abstract. The researcher set the minimum number of co-occurrences at 7, meaning that only terms used in 7 different articles will appear in the VoSviewer visualization. The produced network visualization is presented in Figure 4.

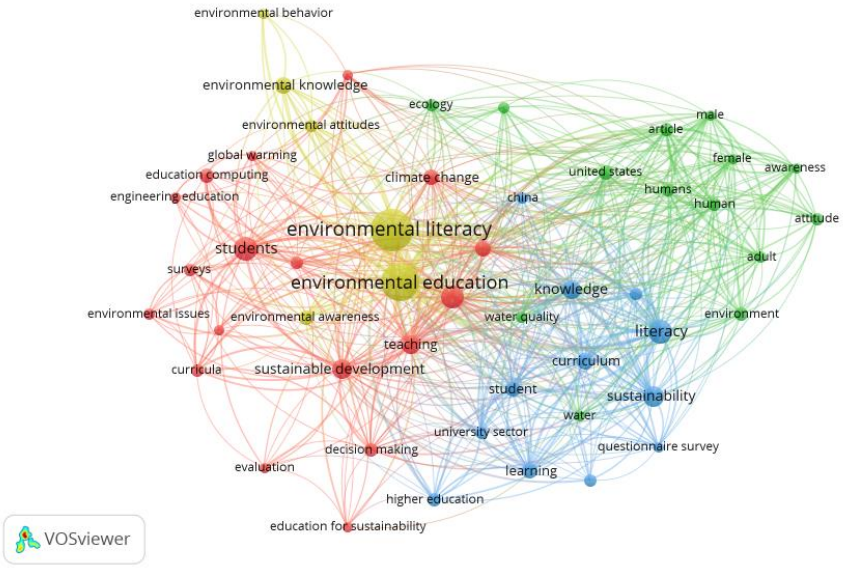

Figure 4. Network Visualization

The visualization shows that the topic of environmental literacy in the context of education is divided into four research focuses indicated by the existence of 4 clusters with 50 terms namely cluster 1 (red) with 18 items, cluster 2 (green) with 14 items, cluster 3 (blue) with 12 items, and cluster 6 (yellow) with 6 items. Besides, environmental literacy is the term that appears most often in which its emergence often coincides with the term environmental education. The density visualization is show in Figure 5.

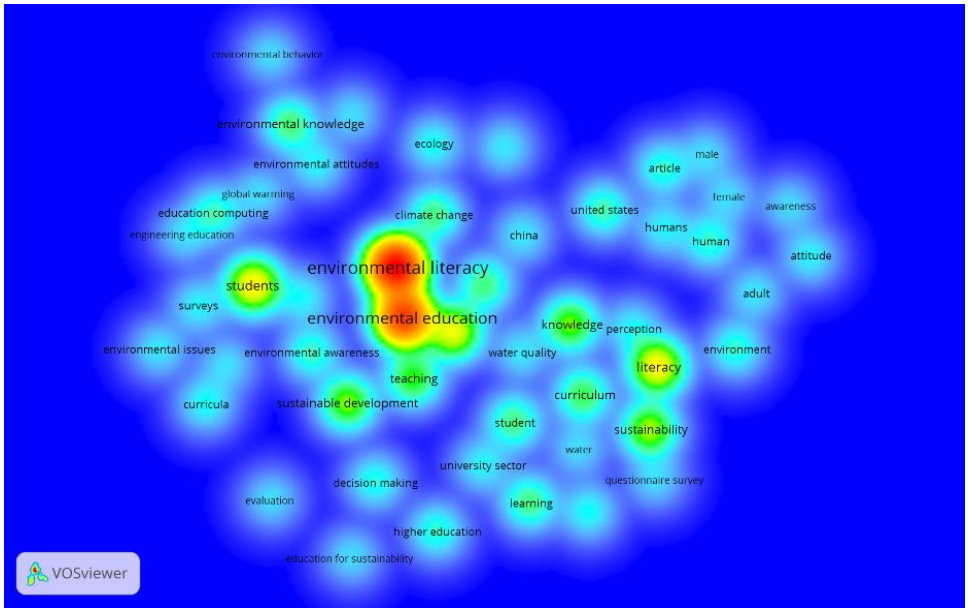

Figure 5. Density Visualization

Base on Table 5, the density visualization showed some terms that have been widely researched, such as environmental literacy, environmental education, students, literacy, and sustainability. Moreover, it provides information on several topics that are rarely researched such as environmental behavior, awareness, evaluation, and others. There has been a shift in research focus in recent years as presented in Figure 6.

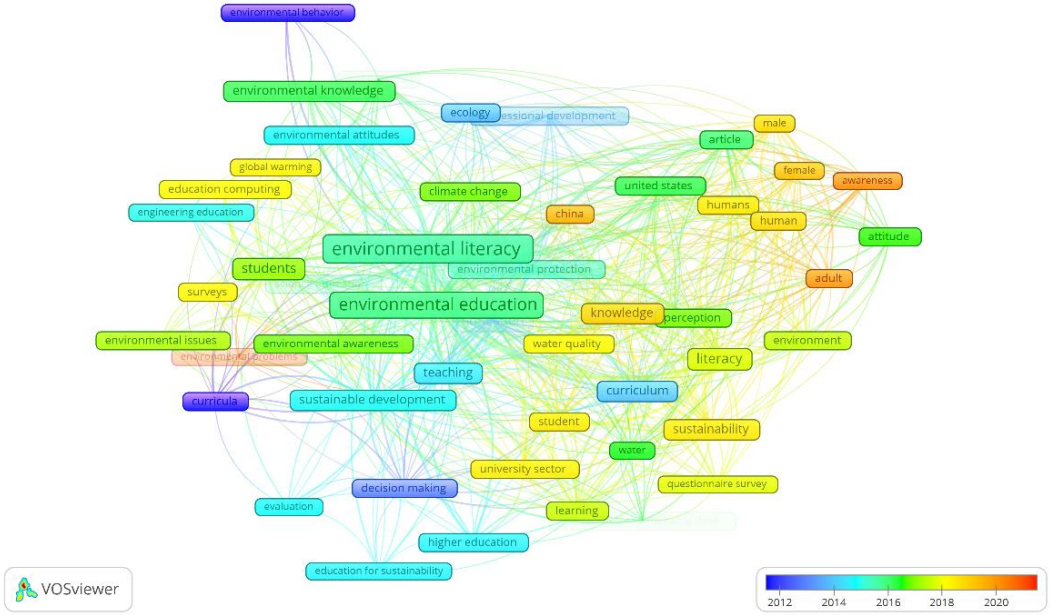

Figure 6. Overplay Visualization

Base on Figure 6, the results of the overplay visualization showed that there has been a change in research focus related to environmental literacy in the educational context in the last decade. In the first 4 years (2012-2015), the issues focused on environmental behavior, curricula/curriculum, decision-making, ecology, environmental attitudes, and environmental protection. Meanwhile, in the last 4 years (2019-2022), the issues were related to environmental problems, awareness, knowledge, sustainability, global warming, and water quality. This can be the basis for academics to develop the topic of environmental literacy in the educational context to be more relevant to the current context to produce useful novelties.

Discussion

Trends of Environmental Literacy Publications

Studies on environmental literacy have not only experienced growth in research productivity but have also been accompanied by significance arising from the research. This is based on the h-Index indicator reaching a value of 39, which indicates that there are at least 39 articles that have been cited 39 times or more. This indicator was developed to measure the level of productivity and impact of work in the scientific world (Hirsch, 2005). The higher the h-Index value, the higher the research productivity and its influence on scientific development. Besides the h-Index, the g-Index introduced by previous study can also be an indicator to measure the level of productivity and impact of a study (Egghe, 2006). G-Index is an extension of h-Index. Therefore, in line with the h-Index, the higher the g-Index value, the greater the research productivity and its impact on scientific progress. Thus, in the 21st century, Environmental literacy is an increasingly important issue in 21st century science development.

The significance of environmental literacy cannot be divorced from the context of the 21st century, characterized by the pervasive influence of technology across various spheres of life, notably impacting the environmental aspect (Parhan & Dwiputra, 2023; Qodr et al., 2021). Transformation not only has a positive impact but also harms environmental conditions by creating various problems. Even, previous study characterizes the 21st century as "The age of global environmental crisis" (Schild, 2016). In light of the swift evolution of technology, it becomes imperative to ensure that its advancement does not engender detrimental effects on the environment. In this pursuit, environmental literacy assumes paramount importance, as it furnishes students with the comprehension, consciousness, and competencies necessary to address prevailing environmental challenges effectively. Moreover, it empowers them to proactively mitigate these issues and forestall their recurrence in the future (Ariyatun et al., 2024; Fang et al., 2023). Therefore, there is an urgent and relevant need to increase publications on environmental literacy in the 21st century, because these publications serve as an important basis for overcoming the various environmental challenges faced.

Despite the increase in publications concerning environmental literacy, it's crucial to acknowledge that research distribution remains largely skewed toward certain nations. This discrepancy underscores an uneven dissemination of environmental literacy research within educational frameworks. Upon closer examination, the countries spearheading research can be categorized into (1) nations with substantial populations, (2) those boasting advanced industrial sectors, or (3) those meeting criteria in both categories. Such delineation signifies a positive development, given that the environmental crisis stems from rapid population expansion, swift industrialization, and increasing consumerism (Ariyatun et al., 2024; Husamah et al., 2022; Lovren & Jablanovic, 2023). Recognizing the pivotal role of environmental literacy in addressing 21st-century environmental challenges, research related to this topic needs to be further improved and disseminated. This effort requires the prioritization of further studies to explain the reasons behind the dominance of only a handful of countries in environmental literacy publications. It is hoped that investigations of this kind will catalyze broader participation and contributions to future research advances in this important field.

Trends of Environmental Literacy Research Topics in Educational Contexts

The topic of environmental literacy cannot be separated from the context of environmental education. This refers to previous study which states that the larger the node, the more often the term appears and the thicker the links between nodes, the more often the terms co-occur (Donthu et al., 2021). In other words, the topics of environmental literacy and environmental education are closely related and have become the focus of significant research. This is reinforced by the density visualization analysis described where colors that have a denser appearance in the visualization indicate the importance and high frequency of appearance of a concept (Eck & Waltman, 2010). It cannot be denied that good environmental literacy is not simply formed in individuals but is the result of the educational process, especially environmental education (Ruan, 2022; Wajdi et al., 2022; Yuan et al., 2020).

Enhancing environmental literacy stands as the primary objective of environmental education, seeking to heighten individual consciousness regarding environmental circumstances. By attaining proficiency in environmental literacy, individuals can gain deeper insights into the interplay between human endeavors and the environment, thereby fostering the pursuit of sustainable development (Sari et al., 2020; Zhang et al., 2021). Therefore, it is important to realize that environmental literacy and environmental education are not only connected conceptually but are also vital and substantial research subjects.

In the 21st century, environmental literacy has long been a subject of study, particularly within the educational sphere. Nevertheless, the continual evolution and growing emphasis on this topic underscores its enduring relevance and critical significance for ongoing investigation. A comprehensive analysis reveals not only a surge in publication activity but also a notable shift in research focus over the past four years. Specifically, environmental literacy research in educational contexts has increasingly prioritized topics such as environmental issues, awareness, knowledge acquisition, sustainability, global warming, and water quality. This trend aligns with the findings of previous study emphasizing the imperative for future environmental literacy research to promote heightened awareness among individuals regarding the significance of acquiring knowledge, fostering attitudes, and cultivating behaviors conducive to addressing diverse environmental challenges in support of sustainability (Ariyatun et al., 2024).

Therefore, the findings in this present study play an important role as a basis for determining research novelty by focusing on topics that are still under-researched with increasing trends such as environmental problems, awareness, knowledge, sustainability, global warming, and water quality. Future studies are expected to provide a more up-to-date and useful contribution to the development of environmental literacy in the educational context. Although this research provides important findings, several limitations should be noted. First, the limited database in Scopus limits the data analysis that can be carried out. Second, this research stops on March 28, 2023, so it does not cover research developments after that date. Therefore, it is recommended to expand the database, use additional data sources, and consider developments in environmental literacy topics in the context of sustainability.

4. CONCLUSION

Environmental literacy in the context of education is not a new research topic, but it is still an interesting topic as indicated by the significant increase in publication and citation rate in the last two decades with the most contribution from America, Indonesia, and Turkey. This indicates that environmental literacy does not only have high relevance but is also a great potential research area to be carried out globally in the 21st century due to its significant impact on the development of science. The bibliometric analysis reveals some limitations related to the diversity of topics discussed in environmental literacy research in the educational context. Despite the recent shift in research focus, research tends to be dominated by certain topics causing a lack of variety and comprehensiveness of research.

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