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Research Trend of Environmental Education in Science Based on Scopus Database

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ABSTRACT

Objective: This study analyzes the trend of implementing environmental education in science research. **Method:** This research was conducted using the bibliometric literature study method. The data collection of this study used a Scopus database and was analyzed by the Vosviewer application. **Result:** From this study known that there is a significant increase in environmental education science research. The highest number of publications carried out in 2021 was six articles. The results of the VOSviewer visualization found 3 clusters red, green, and blue. Red cluster show related keyword research about education, curriculum, learning science, and education program. Green cluster show related keyword research about environmental education and science education. Blue cluster show related keyword research about sustainable development, science and technology, environmental technology, environmental science, and environmental sustainability. From the cluster, there are known that some theme related can be used to combine and use to research environmental education in science. **Novelty:** Analysis of these research trends can be used as a reference and a means of developing self-abilities concerning being an environmental educator in schools. Implementing environmental education can make students better understand and explore their abilities in science.

INTRODUCTION

Science is a branch of science that studies many parts of the universe. Science is a science that includes knowledge, research, and ways of thinking. Research in science education requires a set of interrelated concepts, including humans, society, the environment, society in life, and the world (Gilmanshina et al., 2018). Science education itself has many essential roles in developing world technology. So that the purpose of studying science is to apply various kinds of science to everyday life to solve various kinds of problems and care about the environment, to solve various kinds of problems and care for the environment and solve problems. Students must be competent to identify, analyze, evaluate, and determine actions. Problems that learners can solve will get meaningful experiences that are acceptable to the memory system of the learner's brain (Setyarsih et al., 2021). These various abilities are to the quality aspects of environmental education (Susilowati et al., 2019).

Environmental concern is a thought process so that students can provide an analysis of environmental issues to form competencies (Chusni, 2022). Environmental education is known as a goal in improving human relations with the environment (Bergman, 2015). The world is in an age of global warming which is expected to continue to reform and improve the world's quality but is also required to reduce damage and pollution. Problems certainly require solutions, so the best solution requires problem-Solving skills (Butterworth et al., 2013). Science learning tends to be one-way, so students look passive in implementing learning. The thinking ability of learners experiences obstacles and is

late in processing information. The thinking ability that must be possessed in the 21st century is solving problems (Setyarsih et al., 2018). By the curriculum that applies to 21st-century learning, the challenges faced in the implementation of learning require the skills of teachers to create innovations that support and improve students' problem-solving skills. Learning in the 21st century, according to Aisyah et al. (2017), has a framework, namely, a) critical thinking and problem-solving skills, b) communication and cooperation skills, c) the ability to develop creativity, d) the ability to utilize information technology systems, e) ability to learn independently, f) ability to understand the use of communication media.

Environmental education is a process of learning that has a relationship with the environment to obtain learning experiences that can be applied to the environment (Sari et al., 2021). Environmental issues are not just a matter of ecology and thought but an understanding of the existence and rationality of science and technology that has contributed to nature as an interdependent relationship between the environment and technology (Hernández et al., 2017). With the increasing environmental issues in the world, environmental education is currently one of the exciting academic research areas to explore. The existence of education is expected to be able to create human resources with high quality and high competitiveness in the future (Anggrayni, 2019). The implementation of environmental education needs to involve teachers as educators in overcoming various obstacles to provide an understanding of environmental education that can help improve environmental education (Hernández et al., 2017). So, in its implementation, all forms of education can be run by previously planned goals. Therefore, teachers as educators need to provide direction to practice skills in solving problems in everyday life in the sense of problems of self-development, cognitive development, and emotional development.

In this case, literature reviews and bibliometric studies in environmental education allow constructing research in the field in local and global coverage to discover the prevailing trends and obstacles that need to be reduced in education. According to (Maz-Machado et al., 2020), bibliometric studies must be conducted to analyze related dynamics and trends for renewal in knowledge and education. Bibliometric studies allow us to find out the research patterns of a field by identifying some of its essential elements. Bibliographic analysis that corresponds to the keywords environmental education can find a wide variety of diverse perspectives on a relatively high thematic cluster (Onopriienko et al., 2021). Studies that show interest in environmental education gain a broad and varied view by analyzing bibliometric studies. Based on this description, researchers aim to find out the diversity of topics regarding environmental education issues in the international realm and represent environmental education in the field of science in order to increase collaboration and novelty in the world of education, especially in the field of science. Various articles reveal the shortcomings, advantages, and strategies that must be carried out to improve the ability of students in environmental education (Kumari, 2021).

RESEARCH METHOD

Bibliometric analysis is used to evaluate the progress of knowledge in the literature using mathematical and statistical approaches (Setyarsih et al., 2021). This research uses a type of literature (library research) that aims to find trends in environmental education and apply them in science learning using bibliometric analysis methods. Data collection has

been carried out since September 2022. Data is processed from 20 articles with a Scopus index with the flow of methods and data collection (Setyarsih et al., 2021), as in **Figure 1.**

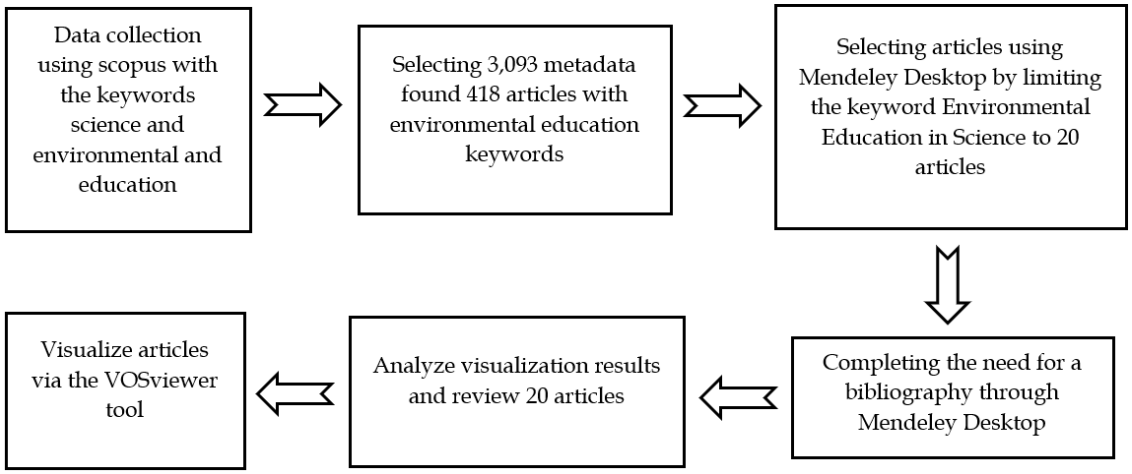

Figure 1. The flow of methods and data collection.

Bibliometric analysis is used as a form of data analysis in various publication journals in a certain period and refers to the discovery of keywords, citations, and authors (Rusly et al., 2019). Data was obtained from Scopus by searching the keywords science, environmental, and education, which obtained as many as 3,093 metadata. From 3,093 metadata, 418 articles with the keyword environmental education were obtained, which were then re-selected to obtain environmental education keyword limits in science through the Mendeley application. The database obtained from Scopus is exported using the RIS form for further analysis. Then, the Scopus document is analyzed using Microsoft Excel and vosviewer (Raman et al., 2021). Microsoft Excel is used to analyze the frequency and percentage of each publication to provide the results of its graphic visualization, and vosviewer is used to generate bibliometric mesh visualizations (Mansour et al., 2021). So that 20 articles were found and analyzed visually through the Vosviewer application. The analysis technique uses Co-Occurrence calculations in the VOSViewer application to find various kinds of research using related topics; corresponding keywords will indicate a relationship between these keywords.

RESULTS AND DISCUSSION

Results

Based on data mapping through Mendeley and VOSviewer in 20 articles on environmental education in science, the number of documents obtained in the Scopus data is shown in Figure 2. The number of articles discussing environmental education in science learning has fluctuating results, namely increasing and decreasing (Schmäing & Frotjohann, 2023). In 2021, the study experienced an increase of more than 50% from the previous year. It can be said that environmental education in science learning still has the potential to continue to be further researched to study and review students' skills in environmental education.

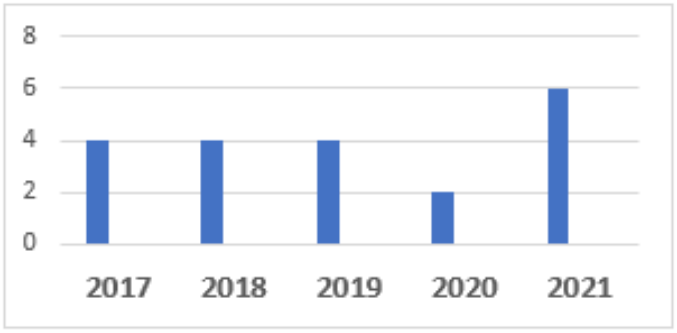

Figure 2. The number of publications ranges.

As many as 20 articles spread over the last five years, with the number of documents decreasing in 2020. This can happen, one of which is the impact of COVID-19 which affects the performance of researchers in conducting research for article creation (Fauzi & Khusuma, 2020). Fortunately, the following year, the number of published articles experienced a significant increase from 2020.

Discussion

Visualization of the Vosviewer Application Environmental Education in Science

Research The results of visualizations based on the Vosviewer application with the topic of environmental education in science can be seen in **Figure 3.**

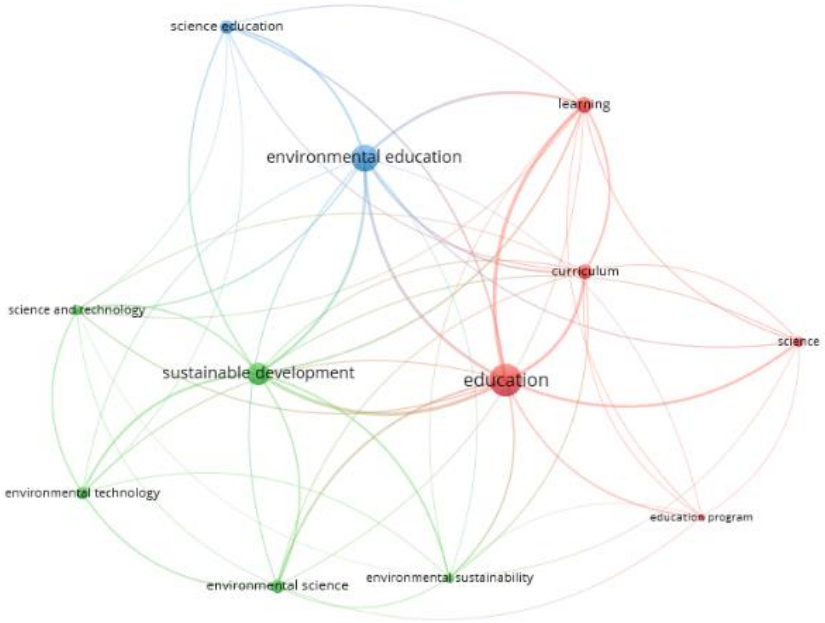

Figure 3. Visualization of the distribution of environmental education in science topics.

Based on the link map, it can be seen that the topic of environmental education in science has a relationship with various keywords, as in the visualization **Figure 3**. The keywords that appear most frequently can be determined by the large number of relevant appearing words that are the unit of analysis of publications with a high frequency on vosviewer (Gao et al., 2022). The distribution in **Figure 3,** among others, consists of 3 clusters: red, green, and blue. The findings in the distribution of keywords are education, environmental education, and sustainable education. The larger the circle of keywords, it can be said that these keywords are often used in environmental education in science.

In the red cluster, the most frequently used keyword is "education," with nets visualizing that all the keywords in **Figure 3** are closely related. The distribution of keywords in the red cluster can be seen in **Table 1.**

Table 1. Distribution of keywords in the red cluster.

Cluster	Keyword
Red	*Education, curriculum, learning, science, education program*

The curriculum is a plan in education used as a guide and handle in all aspects of education. In the process, the implementation of learning has specific goals that will be achieved. This goal is undoubtedly summarized as the main thing in the curriculum.

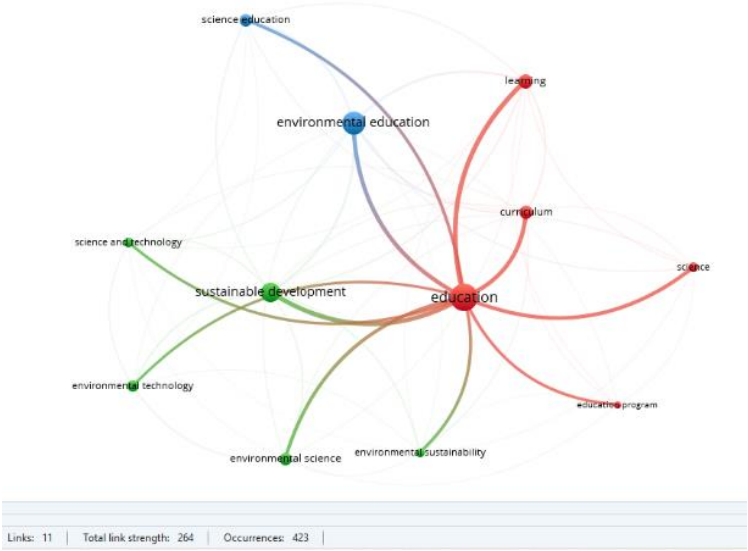

Figure 4. Map of the relationship between education and science and environmental education.

The use of the keyword education is the most in-demand trend. The frequency of the emergence of the keyword education is 423 times. In the blue cluster, the keyword often used is environmental education, which is closely related to the topic raised. In **Table 2**, the distribution of environmental education keywords has one keyword, namely science education. Science education has a connection and focuses on environmental education that strives to continuously increase the involvement of students in the use of the environment as a learning resource.

Table 2. Keyword distribution on blue clusters.

Cluster	Keyword
Blue	*Environmental education, science education*

Furthermore, the most widely used keyword in the green cluster is sustainable development. As many already know, environmental education is very closely related to sustainable development (Garrison et al., 2014). Cluster deployments of sustainable development are seen in **Table 3**.

Table 3. The distribution of keywords in the green cluster.

Cluster	Keyword
Green	*Sustainable development, science, and technology, environmental technology, environmental science, environmental sustainability*

Currently, the world is faced with the era of society 5.0, which requires the capabilities of the 21st century. 21st-century skills are expected to have six basic literacy (numeracy, information, science, financial, cultural, and civic literacy) and behaviors that reflect Pancasila students (Director General of Primary Education and Dikmen, 2021). The social era 5.0 comes by offering a variety of new models that can solve problems in achieving Sustainable Development Goals (SDGs). The relationship between environmental education in science and sustainable development can be seen in **Figure 5**.

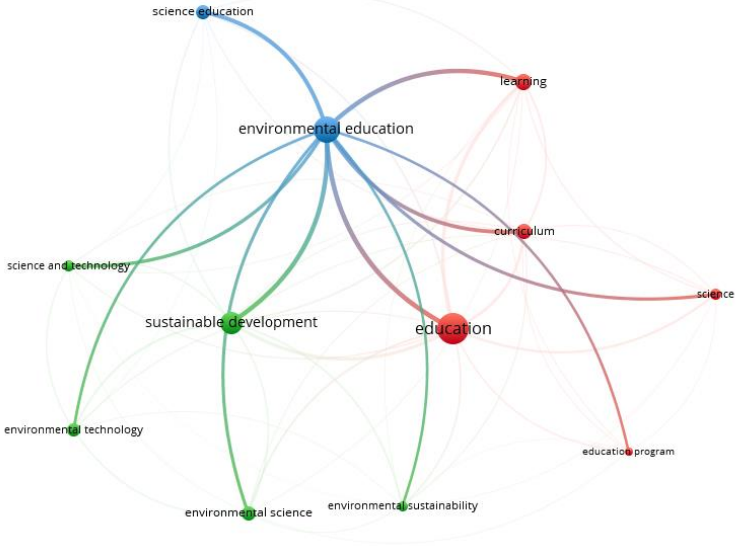

Figure 5. The relationship between environmental education and science and sustainable development.

More emphasis is needed on environmental education to realize sustainable development. This is what makes evidence that environmental education can be a way to realize sustainable development, which is now a hot topic in world discussions. Education can create more qualified human resources and high competitiveness in the future (Anggryani, 2019).

The Study of Environmental Education in Science

Environmental education requires a broad insertion of content development in education in all matters affecting all subjects, including concepts, methods, procedures, methodologies, and problems (Solis et al., 2015). In its implementation, environmental education in science has various things that must be considered to realize sustainable development goals. Things to pay attention to are summarized in **Table 4.**

Table 4. Things that must be considered in the implementation of education.

Author	Publication Years	Result
Hernández et al.	2017	Necessary to involve teachers in overcoming barriers and supporting immersion in a culture of complexity; the understanding of environmental education on this conception demonstrates the importance of a vision that can help improve the basis of environmental education.
Amran et al.	2019	Students' environmental awareness is taught through classroom learning and influenced by culture and habits in the school environment. The attitudes of 21st-century learners can be

Author	Publication Years	Result
		categorized as low, and the environmental awareness of learners can be summed up in the sufficient category.
Wilujeng et al.	2019	Competencies in the learning process are systems of thinking, action-oriented, thinking far ahead and strategizing, and collaborating. The Environmental Education Sustainable Development approach is an innovation in education to prepare the younger generation who care about the environment.
Tapilouw et al.	2018	The ideal Science teacher should master the environment concept through many references. In teacher training, there should be sessions to strengthen knowledge and skills that meet the needs of teachers and support teacher development in environmental science education.
Hidayati et al.	2021	The level of understanding of the concept of environmental education in electricity and its implementation in general still needs to be improved. Understanding these concepts needs to be introduced to learners to be able to apply them in everyday life.
Smith et al.	2021	Multiple pathways to engage with environmental and science topics can improve learners' learning outcomes. Incorporating options into the science curriculum is structured to accommodate diverse learners with different interests, ultimately encouraging multiple pathways to engage with science.
Kaya & Elster	2017	Teachers need to be aware of the changing role of environmental education by facilitating inquiry-based learning in the classroom. Environmental education's interests, scope, and competence should be clearer to ensure a higher quality of science education.
Winanti et al.	2019	The achievement of environmental education goals may be realized by strengthening several themes coupled with optimal learning facilities and resources, teacher training, and improving the grading system

.

Environmental education is considered the most reliable way of changing human lifestyles; in its implementation, educators are the most relevant actors for it. Based on the results of studies from some of these articles, many explain that in their implementation, environmental education in science must pay attention to several things to realize pre-existing goals. As agents of change, educators have to transmit knowledge and an attitude to practice and actively foster learners' environment (Rivera, 2017).

The Role of The Curriculum in the Implementation of Environmental Education in Science

The curriculum is one of the crucial references in implementing education to improve the quality of education. Curriculum can be said to be a learning experience that is any way to obtain student learning experiences under the guidance of educators. Science curriculum standards should emphasize essential relationships with the environment in preparation for real-world situations. The role of the curriculum in implementing environmental education in science is in **Table 5**.

Table 5. The role of curricula in environmental education in science.

Author	Publication Years	Result
Paige	2017	The balance between pedagogical experience ensures preservice teachers recognize the importance of environmental education in both personal and social life, so it needs to be applied to science learning curricula.
Bopardikar et al.	2021	The challenges faced by school-based citizen science curriculum designers aimed at supporting environmental education. This research reveals the ideas in the curriculum and puts forward careful thinking.
Mejía-Cáceres et al.	2021	This policy does not affect the objectives of environmental education programs. Science learning that is dominant in the curriculum is associated with environmental issues that do not have a close relationship with socio-politics

Based on the analysis of the reference article in **Table 5**, the curriculum has a vital role in education. The curriculum is an educational design that has a strategic role in every aspect of activities in education (Mulyasari, 2018). Educators are the spearhead for the implementation of the educational process in the field in order to achieve the objectives of the curriculum. The curriculum can also be designed to shape a person's disposition, nature, and attitudes, including students and teachers as educators. Of course, environmental education applied to science learning has advantages (Castellanos & Queiruga, 2022). It is mainly related to problems in the environment around the residence. Several studies reveal the advantages of environmental education in science learning, summarized in **Table 6.**

Table 6. Advantages of environmental education in science learning.

Author	Publication Years	Result
Lopera-Perez et al.	2021	Environmental Education is a new field that attracts researchers from different fields of knowledge and is enriched through collaboration, the relevance of the consolidation of research networks
Susilowati et al.	2019	The development of science learning tools on the topic of global warming is an excellent category that has the characteristics to foster environmental literacy.
Kuvac & Koc	2018	A significant increase in statistics supported the environmental attitudes of the experimental group's preservice science teachers.
Karyadi et al.	2018	Students who are taught environmental education have good performance and critical thinking. There are books as a product of this research that teachers and practitioners can use in carrying out environmental conservation learning activities.
Gilmanshina et al.	2018	Environmental problems form thoughts for solving problems in the theory of environmental education as necessary qualities and factors forming the educational system of intelligence and decency and ecological attitudes toward nature.

Author	Publication Years	Result
Dumrauf & Cordero	2020	The teacher's participation in decision-making is created during the work process based on the contributions and learning processes achieved by the students to obtain the essential characteristics that are presented, outlining the approach.
Nuhoğlu	2020	Students know the problems around them, try to find solutions, and use scientific approaches to become more adaptable and productive in finding hidden problems and developing compelling propositions for solving problems.

These advantages are expected to continue motivating educators to apply environmental education in science learning to realize world goals in sustainable development. However, in the advantages of course, environmental education in science learning also has disadvantages encountered when applied learning comes from the educator himself. These deficiencies are seen in **Table 7**.

Table 7. Deficiencies in the implementation of environmental education.

Author	Publication Years	Result
Mithen et al.	2021	The ability of science teachers to carry out integrated evaluations of environmental education in science subjects is categorized as poor because of insufficient ability to identify environmental links. In addition, it is revealed that some teachers know this but need more time and opportunity to identify it.
Rivera et al.	2017	From the three principal axes (knowledge, attitudes, practices) in environmental education, teachers satisfy the axis of attitudes of teaching environmental education in science. Teachers have yet to implement this in a unified manner by contemplating the three principal axes.

Judging by the reference to the article, the shortcomings come from educators who have flaws. Therefore, teachers as educators are expected to continue developing their abilities because they have a vital role in creating awareness of the environment, eventually achieving a balance of relationships between humans, the social environment, and nature (Rivera et al., 2017).

CONCLUSIONS

Fundamental Finding: Based on the analysis of the articles described above, it is concluded that research trends on environmental education in science are still being carried out and are increasing. **Implication:** Analysis of these research trends can be used as a reference and a means of developing self-abilities concerning being an environmental educator in schools. Implementing environmental education can make students better understand and explore their abilities in science. Problems in the environment can shape the thinking of learners to solve problems in the theory of environmental education as a necessary quality and a forming factor of the educational system of intelligence and politeness, ecological attitudes towards nature. In developing these abilities, educators can take advantage of everything and apply all aspects of it to daily life. Teachers can use environmental education to provide information about the relationship between science

in their environment as a delivery of material in learning. **Limitation:** This research is limited to descriptions of environmental learning at various levels from 2017-2021, with the chosen keyword being environmental education in science. **Future Research:** In its implementation, teachers must continue providing guidance and directing students to understand and explore environmental education in science well. The hope is that this research can continue to improve the human ability for environmental sustainability obtained in science at the formal education level.

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