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Trends of ESD Oriented RADEC Learning Model in Elementary Education: Review and Bibliometric Analysis

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Abstract: The purpose of the study was to provide a thorough bibliometric assessment of the literature on the RADEC (Read, Answer, Discuss, Explain, and Create) learning model for primary schools that are oriented toward education for sustainable development. articles discovered using the Google Scholar database and the Publish or Perish software (PoP). From 2015 to 2022, 200 papers were located in the Google Scholar database. Utilizing the reference manager Zotero, the chosen articles were then managed. The researcher organized the database, and then used VOS-viewer software to categorize and visualize it. The results are based on research, it is necessary to implement ESD that develops sustainability consciousness competencies, namely abilities that include knowledge about sustainable development, attitudes, and behaviors that contribute to achieving the Sustainable Development Goals (SDGs). It is necessary to apply a model that has adequate steps to develop the competence of sustainable consciousness. One of the solutions carried out by researchers is implementing ESD through the ESD-oriented RADEC learning model. Through the development of the ESD-oriented RADEC learning model, it is hoped that it will be able to provide knowledge and skills in environmentally friendly practices and even stick to sustainable attitudes and behavior in each student. The implementation of the ESD-oriented RADEC model can be applied to all disciplines, not only environmental education.

Keywords: ESD; Primary schools; RADEC Learning Model; Sustainability consciousness

Introduction

Development is a process of change to achieve community welfare in various perspectives of human life The implementation of systematic and continuous development is in a better direction and preceded by social changes in the community (Hendriawan & Ali, 2019). The social change in question is a society that was previously bound by tradition, unproductive, living in a constellation so that it becomes a society with a good work ethic, productive and future-oriented (Shutaleva & Nikonova, 2020).

Development always takes place continuously, progressively, and rapidly (Yulianti et al., 2022). Conventional development leads to economic growth that does not pay attention to environmental conservation, so it tends to negatively impact the environment because natural resources are exploited and explored excessively (Ali, 2018; Lestari & Sopandi, 2021). This results in environmental damage and pollution globally and has the potential to destroy the performance of economic growth and development itself.

The availability of natural resources does not automatically correlate with rapid development and economic progress; rather, the availability of energy, food, and clean water is decreasing, leading to a variety of environmental issues (Lestari & Siskandar, 2020). The fact that 50% of the world's tropical forests are damaged and that the concentration of carbon dioxide in the

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atmosphere is expected to increase by 29% by 2030, causing global warming, extreme climate change, air pollution, a water crisis, and poverty for 850 million people, serves as further evidence of this imbalance, in a world where there is a food deficit (Lestari et al., 2022; UNESCO, 2017).

Indonesia, with its development progress and economic growth, cannot escape the problems of environmental damage and pollution (Gunansyah et al., 2021). The biggest issues that harm the environment are poverty and a lack of education (Maurer et al., 2020; Mcgregor, 2019; Sinakou & Boeve-de Pauw, 2019). According to the Central Statistics Agency (BPS), there are 26.42 million poor and unschooled persons in the world as of 2020, a rise of 1.63 million people per year (Ali, 2017; Murniningtyas & Endah, 2018).

The community is aware of the connections between environmental harm and issues and social and economic advancement. Sustainable development for future generations requires balancing social, environmental, and economic needs. The community is aware that measures to boost economic growth and promote education and health also aim to reduce poverty (Ortega-Sánchez et al., 2020; Saini et al., 2023; Timm & Barth, 2020; Zulkarnaen et al., 2023). The international community is committed to putting the idea of sustainable development into practice to address these issues. The United Nations (UN) member countries work together to tackle environmental degradation and damage that are continuously exploited as a result of development that ignores aspects of environmental protection in member countries (Ali, 2017; Olsson et al., 2022).

Education for Sustainable Development (ESD) is a United Nations (UN) program whose implementation is outlined in the program of the world body tasked with dealing with science, education, and culture, namely the United Nations Educational and Scientific Organization (UNESCO) (UNESCO, 2018). UNESCO was then appointed as the main implementer of ESD in reorienting education to achieve sustainable development (Lestari, 2020).

ESD was born from the need for education to respond to the ever-evolving challenges of sustainability (UNESCO, 2018). The United Nations defines ESD as an approach to the learning process-oriented to the principles and ideals of sustainable development (Kalman, 2017; Liu et al., 2020). People of all ages are given the ability to contribute to building a sustainable future through the ESD idea (Bezeljak & Scheuch, 2020). To accomplish the future of sustainable development within the context of environmental integration, sustainable economic development, and a just community for both current and future generations, ESD is a lifelong education program (Cicmil et al., 2017; Komarudin & Mohammad, 2019).

The achievement of ESD in elementary schools has become an important agenda, especially for UN member states. These countries have debated ESD in the primary school curriculum for inclusion in subject syllabuses, textbooks, learning assessments, and pedagogical methods (Nousheen et al., 2020; Ornstein & Hunkins, 2018). Basic education is a forum that can implement ESD competencies in developing students' understanding, skills, and behavior to achieve sustainable development goals (Wahyudin, 2018). Learning in elementary schools is packaged in thematic learning so that it can provide opportunities in the process of implementing ESD holistically and comprehensively (Hilman & Dewi, 2021; Soler et al., 2017).

ESD must be integrated into the basic education curriculum to raise students' understanding of sustainable development as well as their awareness of sustainable attitudes and behaviors that support the achievement of the fourth Sustainable Development Goal (SDG), which is excellent education (Lestari et al., 2022; Pal, 2023). ESD instills and teaches the values of sustainable development in all aspects, both environmental, social, and economic to provide an understanding of sustainable development so that students are expected to have sustainable awareness, especially in facing global problems and also think critically and creatively on how to overcome a problem taking into account the impact it will have on various aspects of life. Teachers in integrating ESD require professional and pedagogical competencies regarding the objectives of ESD, dimensions of ESD, and ESD competencies so that ESD can be implemented holistically and integrative in the content of the learning curriculum.

It is important to adapt ESD in elementary schools because teachers lack the knowledge and expertise necessary to do so, which prevents children from gaining a long-lasting awareness of the issue (55% principals and 67% teachers do not yet fully understand the concepts, objectives, policies, ESD governance and programs); The achievement of ESD implementation in Adiwiyata schools is relatively low at 27%; It is necessary to develop a curricular implementation strategy to improve students' knowledge, skills and behavior to achieve sustainable development goals; teachers have difficulty implementing learning models that can develop sustainable awareness behavior; an innovative learning model is needed that is in accordance with the curriculum used by the characteristics of teachers and students who are able to develop not only conceptual understanding, but students' attitudes and behavior towards sustainable awareness; ESD is taught to students

not holistically, most teachers implement ESD only on the environmental dimension. The ESD concept, on the other hand, is an integrated idea of the three aspects of sustainable development that is comprehensive and sustainable (Kandangama, 2018; Nordén, 2018).

The RADEC learning paradigm was created based on the traits of Indonesian students and the current circumstances of the Indonesian nation (Lestari & Suhandi, 2020; Sopandi, 2019; Sukardi et al., 2021; Sukmawati et al., 2020). Each step in the RADEC learning paradigm supports not just a gain in conceptual understanding but also a variety of 21st-century abilities and thoroughly improves students' character and attitudes. The steps are simple for teachers to memorize and utilize in learning (Lestari & Sopandi, 2021; Sopandi, 2017; Sukmawati et al., 2020; Yulianti et al., 2022). The RADEC learning paradigm is ideal for creating the learning phases that researchers are trying to build. The distinctive feature of this research is that the RADEC learning model will be developed with the objectives of sustainable development (Handayani et al., 2019; Yulianti et al., 2022). Students will also benefit from developing attitudes toward sustainability and a conceptual grasp of sustainable development. ESD goals are based on learning indicators that are stage-based, and ESD elements include sustainability in the social, economic, and environmental domains.

Based on this explanation, the implementation of ESD in elementary schools requires a new direction with a pedagogical approach to developing ESD competencies that need to be mastered by students, namely, an understanding of sustainable development, 21st-century thinking skills (critical, creative, collaborative, communicative) and the character of awareness of sustainability and holistically by applying a learning model that is under the characteristics of the Indonesian curriculum (Singh & Thurman, 2019; Trott & Weinberg, 2020). The purpose of the study was to conduct a thorough bibliometric assessment of the literature on the ESD-focused RADEC learning paradigm in primary schools. articles discovered using the Google Scholar database and the Publish or Perish software (PoP). From 2015 to 2022, 200 papers were located in the Google Scholar database. Utilizing the reference manager Zotero, the chosen articles were then managed. The research organized the database, then used VOS-viewer software to categorize and visualize it.

Method

Research design

This bibliometric research method adopts the five-step method developed by Tranfield et al. (2003), namely determining search keywords, collecting initial search results, refining search results, compiling initial data statistics, and analyzing data (Ornstein & Hunkins, 2018).

Procedures and Data Analysis

Conducting a literature search using the terms "ESD Oriented RADEC Learning Model" and "Sustainability consciousness" is the first step. The largest database was chosen, Google Scholar and the most efficient method for searching for articles on GS was found to be Publish or Perish. The next step is to do a targeted search for the years 2005 through 2022. The initial search turned up 200 articles from the publication. The data is gathered in a Research Information System (RIS) format, which includes all crucial article data like the title of the paper, the name and affiliation of the authors, the abstract, the keywords, and the references (Sukardi et al., 2022).

The following step is to select and filter items using GS. The selection method excludes media commentary, book reviews, book chapters, and proceedings from international seminars. Once imported into the Zotero bibliographic tool, the filtered data is saved as a RIS file. The fourth phase is the revision of the data in the RIS. The journal article's commencement details, such as the year of publication, volume, number, and pages, should be double-checked to ensure accuracy. If there is not enough information provided, the components are reviewed and the necessary data is changed. The Publish or Perish (PoP) program is used to carry out a bibliometric analysis in the fifth step. The Vos-viewer software, which is efficient at providing a variety of engaging visualizations, analyses, and studies, is used to display the bibliometric network (Hudha et al., 2020; van Eck & Waltman, 2010). Additionally, Vos-viewer may develop publisher, author, or journal maps based on co-citation networks or keyword maps based on shared networks.

Result and Discussion

According to a bibliometric analysis conducted with the Publish or Perish (PoP) program, the number of citations for the keywords ESD, consciousness, RADEC learning model, and basic education from 200 journal articles on Google Scholar between 2015 and 2022 is in 2020. The average number of citations is 10.10 per piece and 288.57 each year. This demonstrates that the theme has the potential to be developed further for a variety of research goals. Figure 1 displays all bibliometrics-related data in its entirety.

Publication years:	2015-2022
Citation years:	7 (2015-2022)
Papers:	200
Citations:	2020
Cites/year:	288.57
Cites/paper:	10.10
Authors/paper:	2.36
h-index:	26
g-index:	38
hI,norm:	17
hI,annual:	2.43
hA-index:	10

Figure 1. Data of Bibliometrics

The researcher makes an effort to offer the most pertinent research contributions. The first step is to select the publications that have the most citations for the keywords "ESD, sustainability consciousness, and the RADEC learning model" (top 10 articles referenced), as shown in Table 1. The most frequently referenced articles are very highly indexed in the reputation area of the journal. The offered keywords and titles are very visible, making it simple for information seekers to find them. The table 1 lists the top ten articles by the number of citations:

Table 1. Ten Articles with the Best Citation.

Author(s)	Titles	Publisher	Journal	Year
Olsson & Gericke (Olsson & Gericke, 2016)	Effects Of The Adolescent Decrease In Students' Environmental Awareness On Sustainable Development Education	Routledge Taylor & Francis	Environmental Education	2016
Nousheen, A., Yousuf Zai, S. A., Waseem, M., & Khan, S. A (McComas & Nouri, 2016)	attitudes of pre-service teachers toward sustainable development as a result of sustainability education in education for sustainable development (ESD)	Elsevier	Journal of Cleaner Production	2019
Guadalupe Martínez (Martínez-Borreguero et al., 2020)	An Integrated Model Approach to Education for Sustainable Development: Exploring the Concepts of Water, Energy, and Waste in Primary Education	Elsevier	Sustainability	2020
C. Borga, N. Gerickea, H.-O. Höglunda & E. Bergman (Borg et al., 2014)	Subject- and experience-bound differences in teachers' conceptual understanding of sustainable development	Routledge Taylor & Francis	Environmental Education Research	2016
Sally Birdsall (Birdsall, 2015)	Analysing teachers' translation of sustainability using a PCK framework	Routledge Taylor & Francis	Environmental Education Research	2015
Asma Id Babou, Omar Jiyed, Bouchta El Batri, Lhoussaine Maskour, El Mostapha Aouine, Anouar Alami and Moncef Zaki (Idbabou et al., 2020)	A case study based on the Ministry's grades and school curriculum from primary through secondary school and qualifying institutions, Education for Sustainable Development and Teaching Biodiversity in the Classroom of the Sciences in The Moroccan School System	SAGE	British Journal of Education	2020
Jana-Michaela Timm & Matthias Barth (Timm & Barth, 2020)	Making education for sustainable development happen in elementary schools: the role of teachers	Routledge Taylor & Francis	Environmental Education Research	2020
Suryana & Sopandi (Suryana & Sopandi, 2021)	Improving Student Literacy Culture Through Implementation Radec Learning Model	Universitas Pendidikan Indonesia	JPPD: Jurnal Pedagogik Pendidikan Dasar	2021
Handayani, Wahyu Sopandi, Syaodih, Suhendra and Hermita (Sopandi & Handayani, 2019)	Alternative Instruction on the Water Cycle for Elementary School Students in Higher Order Thinking Skills	IOP Publishing	Journal of Physics: Conference	2019

Author(s)	Titles	Publisher	Journal	Year
Hana Lestari, Mohammad Ali, Wahyu Sopandi, Ana Ratna Wulan (Lestari et al., 2021)	Infusion of Environment Dimension of ESD into Science Learning Through the RADEC Learning Model in Elementary Schools.	Universitas Negeri Mataram	Journal of Research in Science Education	2021

Table 1 shows that the focus of research is on the implementation of ESD in the learning process in schools, the obstacles found in implementing ESD, and the ESD competencies that must be developed. The visualization display of the Google Scholar data network for ESD, sustainability consciousness, and the RADEC learning model, is shown in Figure 2 below:

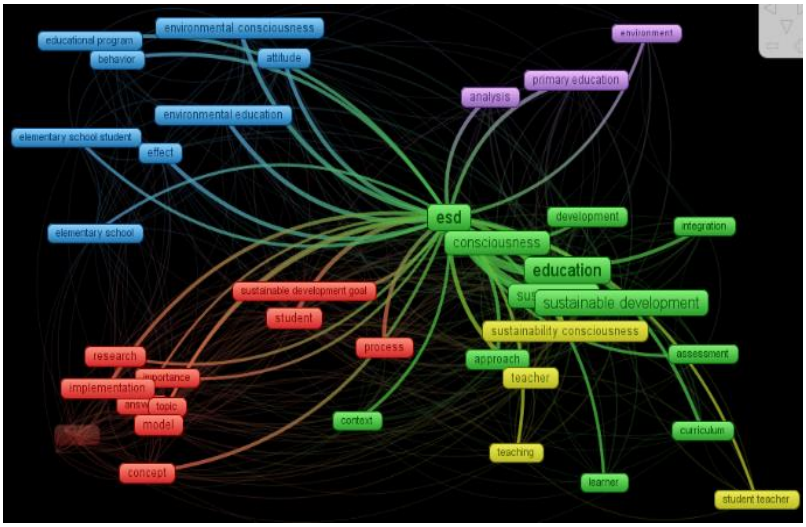

Figure 2. Network Visualization on Google Scholar Data for ESD

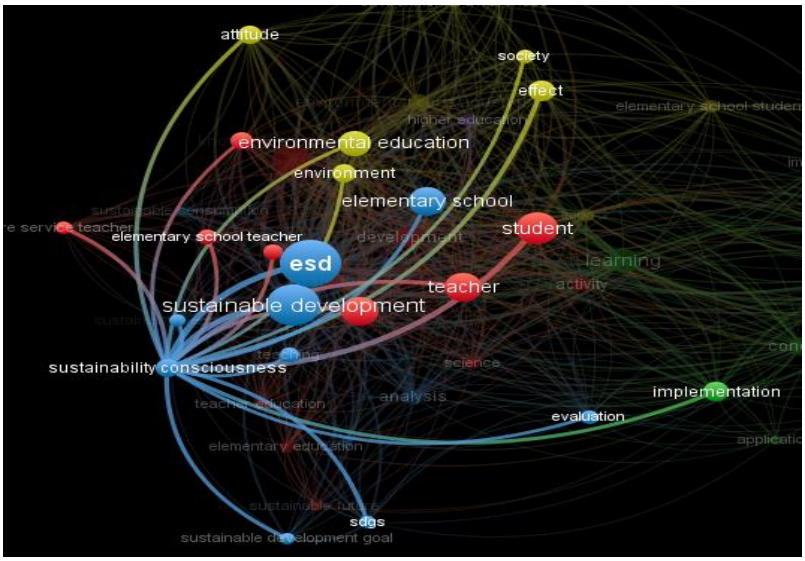

Figure 3. Network Visualization on Google Scholar Data for sustainability consciousness

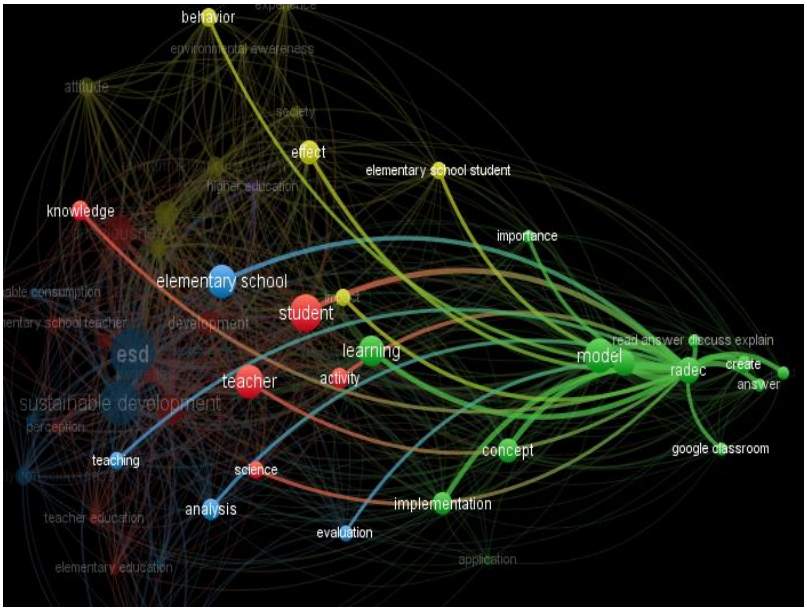

Figure 4. Network Visualization on Google Scholar Data for RADEC Learning Model

As seen in Figure 2,3,4, some of the concepts that emerge are tendencies of the variables studied. The concept of sustainability consciousness, curriculum, integration, approach, context, and sustainable development goals are words that appear in network visualization. This shows that ESD needs to be integrated with the curriculum in the form of an approach to achieve sustainable development goals where students can develop not only knowledge about sustainability but attitudes and behaviors to be able to preserve the environment so that natural resources can meet the needs of current and future generations.

The words "sustainable development goals," "ESD implementation," "environmental education," and "basic education" may all be seen in the network visualization of the sustainability consciousness variable. This suggests that sustainability consciousness is one of the ESD competencies that must be achieved by students to attain sustainable development goals. Words related to science education, fundamental education, knowledge, attitudes, behavior, and creative thinking skills can be seen in the network visualization of the RADEC learning model variables. This demonstrates that one of the learning strategies that can help students grow their knowledge, abilities, attitudes, and behavior in science learning and fundamental education is the RADEC learning model. Figure 3 below shows a more detailed network depiction of the three variables.

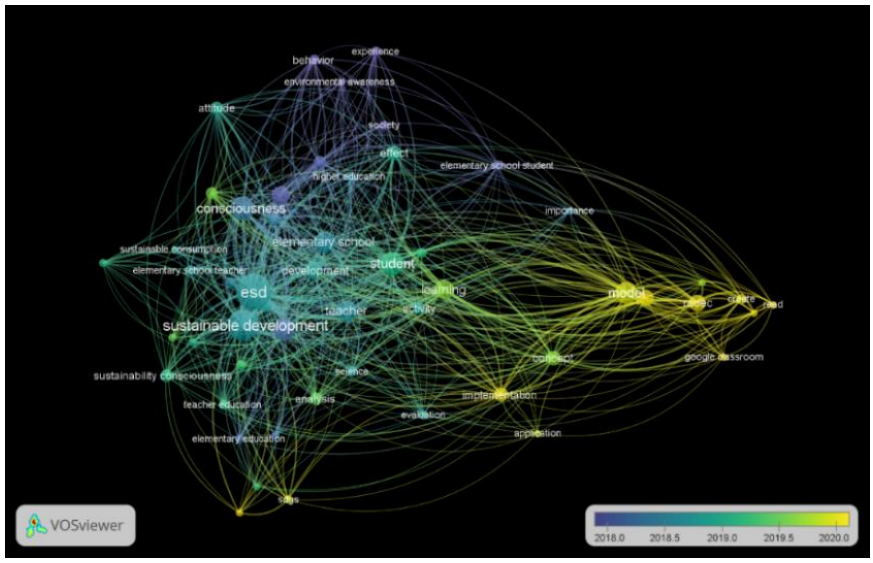

Figure 5. Network Overlays on Google Scholar Data

Figure 5 shows the timeline of each keyword in the network overlay until 2020. The major themes in any study or field of knowledge are identified using this visualization overlay analysis (Liu et al., 2015). Before the development of the RADEC learning paradigm, ESD attracted research interest. The lack of research on the ESD-oriented RADEC learning model is evident from the network visualization display and network overlay, which means there are several prospects for further study.

The RADEC learning paradigm was created based on the traits of Indonesian students and the current circumstances of the Indonesian nation. The RADEC approach features learning phases that are simple for teachers to recall and use in lessons; each step helps students develop their character and attitudes holistically while also broadening their conceptual understanding and developing a variety of abilities. The RADEC learning model is particularly well suited for the construction of the learning stages that researchers intend to design based on its properties. In this study, the RADEC learning model, which was developed for sustainable development is new because it aids in students' development of both a sustainable development understanding and behaviors that are in harmony with nature. ESD dimensions take into account environmental, economic, and social concerns holistically, and learning is based on learning indicators that are directed at ESD goals.

Conclusion

The goal of this study is to identify themes in journal papers that are connected to the keywords "ESD-oriented RADEC Learning Model and sustainability consciousness." The PoP software gathered articles from the GS database. Then 200 publications that were published between 2015 and 2022 were chosen for additional analysis. The findings of bibliometric analysis using a VOS reader demonstrate that despite numerous challenges, there is still a very high level of research on trends in the ESD-oriented RADEC learning model in primary school. According to earlier research, it is essential to apply ESD that fosters sustainability consciousness competencies, or skills that comprise sustainable development knowledge, attitudes, and behaviors that help achieve the Sustainable Development Goals (SDGs). Applying a model with sufficient steps is important to cultivate sustainability consciousness competency. Implementing ESD using the ESD-oriented RADEC learning model is one of the solutions used by researchers. It is believed that through creating the ESD-focused RADEC learning model, each student will be able to gain knowledge and abilities in sustainable practices as well as maintain sustainable attitudes and behavior. All fields, not just environmental education, can use the implementation of the ESD-oriented RADEC paradigm.

Since the ESD-focused RADEC learning model was not created by Sopandi and other academics on their own, it is currently the director of a new pedagogical strategy to help overcome numerous obstacles to ESD adoption in elementary schools. Researchers' learning resources demonstrate the expansion of RADEC learning with an ESD focus. Lesson plans, student workbooks, pre-learning questions, teaching materials, and tests are the in-question learning tools. The ESD-focused RADEC learning strategy utilized in this study aims to improve the sustainability understanding of elementary school students.

Author Contribution

Hana Lestari and Ima Rahmawati: wrote the article draft, revised and edited the final article. Mohammad Ali: revised and developed the draft article. Wahyu Sopandi: revised and developed the draft article. Ana Ratna Wulan: revised and developed the draft article.

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2022 Budget

Conflicts of Interest

There is no conflict of interest

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