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GREENING THE SCIENCE CLASSROOM: A COMPREHENSIVE REVIEW ENVIRONMENTAL EDUCATION PRACTICES

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Abstract:

The implementation of a high-quality education system is necessary to face all the rapid changes in the world. The education system needs to be adapted to the problems faced such as environmental problems faced by modern humans today. Green education is an education system consisting of programs, tools and policies that aim to produce environmentally sustainable individuals. Eco-friendly education and training that emphasizes the sustainable use of resources and the application of environmental conservation is the idea behind greening the classroom. This systematic review aims to review the development and implementation of environmental education for greening science classrooms. The systematic review was designed based on the PRISMA Statement (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). The review was conducted using the three steps listed in the PRISMA diagram, including identification, screening and inclusion. Furthermore, data sources came from SCOPUS, Google Scholar and ERIC, articles from third sites were only retrieved between 2018 and 2024. Several criteria for evaluation and scoring were considered. The article search was refocused by using keywords related to the topic and question statement. Further review of the articles resulted in three major themes. These themes consisted of greening science classrooms and environmental education, challenges or barriers in implementing environmental education and also innovative pedagogical strategies. It is hoped that this study will serve as a reference in the development of environmental education and future researchers.

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Keywords:

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Introduction

The changes taking place in the world today are quite worrying and sad. The condition of the earth, where humans live, is starting to become worrying. Global warming and environmental issues as well as dynamic human development are increasingly worsening the condition of the earth. Dynamic human development certainly gives rise to new challenges such as uncontrolled technological progress, social and cultural developments, massive individual growth, expansion of the world economy, decline in adequate ecosystem land, all of which are interrelated in supporting survival. If challenges like this cannot be handled properly, it will increase the vulnerability of modern individuals to the dangers of exposure to nature and technology. However, to be able to overcome these problems all can be done by paying more attention to the education system throughout the world (Kurup et al., 2021). The education that needs to be promoted now is education that leads to environmental improvement.

Greening education is an education system that innovates and integrates with a sustainable environment. The concept presented in the implementation of greening classrooms is environmental teaching and training based on eco-friendly, use of sustainable resources and adopting the concept of environmental conservation (Poza-Vilches et al., 2022). This is all intended to increase and encourage students' awareness of the surrounding environment and the deteriorating condition of the earth. We can logically say that by increasing public awareness and knowledge of global conditions, global conditions can improve. And of course global conditions can be controlled through an education system that focuses on the environment. However, in implementing this approach in educational units, of course many problems are faced, such as challenges faced by teachers, lack of resources, teacher training and curriculum alignment, as well as various other varied challenges. Apart from that, in implementing environment-based education it is also necessary to determine the best pedagogical and teaching methods. And this of course requires planning and design as well as good observation to determine it.

Literature Review

Table 1: Matrix Table

Author/Year	Country	Design	Data Collection Method	Findings and Result
(Marpa, 2020)	Philippines	Qualitative and Quantitative	Adapted questionnaire and semi-structured interview questions	• Challenges and barriers including the resource constraints and teacher training. • Teachers are generally willing to integrate EE into their teaching but face challenges such as a lack of instructional materials, and insufficient training.
(Waltner et al., 2020)	Germany	Quantitative	Online questionnaire administered using the software package Unipark (questback).	• Challenges and barriers in implementing EE including the resource constraints and teacher training.

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Author/Year	Country	Design	Data Collection Method	Findings and Result
				• Lack of teacher training and teaching materials were identified as hindrances to the integration of sustainability issues in the classroom.
(Van Dijk-Wesselius et al., 2020)	Netherlands	Quantitative and Qualitative	Collaborative action research design	• Pedagogy that used in implementing of EE namely outdoor learning or field trip. • Barrier that faced when implementing the environment education which is lack of confidence in outdoor teaching expertise.
(Fajri et al., 2023)	Indonesia	Qualitative	Interviews and document review	• Challenges and barriers including the resource constraints and teacher training. • The study identifies several challenges to the successful implementation of EE, such as budget constraints, logistical issues, and the need for more effective collaboration between schools, government, and society.
(Huoponen, 2023)	Finland	Qualitative	Interviews	• The barriers that faced during the implementation of EE • During the implementation of EE, the students had the lack of environmental literacy levels.
(Zamora, 2023)	Philippines	Qualitative	Review and analysis	• Pedagogy that used in implementing of EE namely CSL or Community Service Learning. • This study suggesting that CSL is an effective pedagogical approach for environmental education.
(Ustun & Tracey, 2021)	Turkey	Qualitative and quantitative	Semi-structured interviews	• Suggest the Blended Learning (BL) approach for implementing EE. • The findings suggest that students were moderately satisfied with the instructional tools and activities in the BL environment.
(Ricardo Barreto et al., 2022)	Colombia	Quantitative	Digital survey	• Incorporation of technology to support the implementing of EE. • The types of technology that used is ICTs, educational platforms, web 2.0 resources, Apps and virtual reality.
(Martínez Valdivia et al., 2023)	Spain	SLR Qualitative	Systematic Review process	• This study explained about teacher training and curriculum alignment in implementing of EE. • The curricula are expected to develop competencies in future teachers that align with the principles of sustainability.

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Author/Year	Country	Design	Data Collection Method	Findings and Result
(Fru & Ndaba, 2023)	South African	Qualitative	Semi-structured interviews	• The study found that educators faced challenges in teaching environmental education due to a lack of resources and a curriculum that did not accommodate it.
(Jardin et al., 2023)	Philippines	Qualitative	Reviews	• Implementation of AR to teach EE • AR enables students to interact with virtual ecosystems, fostering a deeper connection to environmental concepts.
(Butler, 2022)	Oregon	Qualitative	Open-ended short-answer questions	• This study explained the importance of experiential learning namely Hands-on learning. • It emphasizes active participation and direct experience.
(Su & Zhao, 2023)	China	Quantitative	*Reviews*	• This study explained the curriculum alignment. • This involves setting up green education courses for students.
(Eliyawati et al., 2023)	Indonesia	Quantitative and qualitative	Online questionnaire-based approach using the Google form platform	• Mentioned the types of teacher training involves the workshop, webinar and field study.
(Ecevit et al., 2020)	Turkey	Quantitative	Teaching-Learning Conceptions Questionnaire (TLCQ)	• This study suggesting the constructivist approach to enhance the active role of students in implementing EE.
(Motevalli et al., 2022)	Malaysia	Qualitative	Surveys, questionnaires, and interviews	• Explained about the Education for Sustainable Development (ESD) to enhance and fostering the knowledge, value, and attitude of students toward to environmental.
(Sofyan A Gani et al., 2023)	Indonesia	Quantitative and qualitative	Surveys, questionnaires and semi-structured interviews	• Limited resource: can hinder the implementation of comprehensive environmental education programs. • Curriculum constraints: The existing curriculum may not allocate sufficient time or resources for environmental education
(Biancardi et al., 2023)	Italy	Quantitative and qualitative	Questionnaire	• This study explained the importance of sustainability education and green education. • The sustainability education be able to fostering transformative innovation and stakeholder engagement.
(Lin et al., 2023)	Taiwan	Quantitative	Data mining techniques	• Implementation AI and IT • Personalized learning experiences, Eco-friendly practices and enhanced flexibility.
(Okada & Gray, 2023)	United Kingdom	Qualitative	Delphi approach	• Using the Care-Know-Do framework for introduced the Climate Change and

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Author/Year	Country	Design	Data Collection Method	Findings and Result
				Sustainability Education (CCSE)
(Manzano-León et al., 2021)	Spain	Quantitative and qualitative	Ad hoc questionnaire and quasi-experimental	• The potential of gamified method to improve public social awareness and can lead students to a change in pro-environmental behavior.
(Mahmud et al., 2020)	Malaysia	Quantitative and qualitative	Pre-test, post-test used a questionnaire and interviews	• Using the mobile application called JouleBug to teach materials in environmental education. • JouleBug can increase the student habits through pro-environmental actions.
(Ouariachi et al., 2020)	Taiwan	Qualitative	Octalysis framework and Games Framework	• Suggest the gamified approach to teach the environmental education. • Six types of gamified; Consumption of Daily Life, Oroeco, SaveOhno, Recyclebank, JouleBug and My Little Plastic Footprint.
(Probosari & Nugraheni, 2021)	Indonesia	Quantitative	Structured questionnaires with a Likert scale for assessment	• The challenges while implementing Adiwiyata program. • Teaches experienced difficulties in stimulating students to apply HOTS related to environment.
(Hana Naqiyya Nada et al., 2021)	Indonesia	Qualitative	A combination of in-depth interviews, thorough observation, and documentation	• Shown the strategies for the implementation of the Adiwiyata program. • Creating innovative environmental activities, and conducting self-regulation
(Husamah et al., 2022)	Indonesia	SLR Qualitative	Systematic review process; identifying, evaluating, and analyzing all available information	• EE as an approach, tool and program to create and develop knowledge and awareness related to environment.
(Nurwidodo et al., 2020)	Indonesia	Quantitative	Survey and questionnaires	• Explain the impact of Adiwiyata program toward to student attitudes. • Suggest the PBL approach as a method to teach EE.
(Maurer et al., 2020)	Greece	Quantitative	Questionnaires	• Green classroom refers to indoor nature in classroom • the positive impacts of indoor nature in classrooms include: Improved perceived environmental quality, and enhanced classroom attractiveness
(Matsekoleng et al., 2024)	South Africa	Qualitative and quantitative	Surveys	• Indigenous games can effectively teach resource management, environmental impact, and problem-solving skills.

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Methodology

Aims

The purpose of this study is to systematically review previous research related to the development and implementation of environmental education for greening science classrooms. The main focus of this study is to analyze the teacher side of green classroom development. We pose several research questions that will lead to a deeper understanding of the subject matter, as follows.

- RQ1: What are the primary challenges and barriers that educators encounter when implementing environmental education in science classrooms, with a focus on resource constraints, teacher training, and curriculum alignment, and how do these challenges vary across different educational settings and regions?
- RQ2: Which innovative pedagogical strategies and teaching methods demonstrate the highest effectiveness in fostering ecological literacy and sustainability awareness among students in science classrooms, and how can these strategies be adapted to meet the evolving needs of future learners?

Design

SLR is a writing technique that makes it possible to collect facts in accordance with the topic being discussed by adopting predetermined criteria and this is done to obtain answers to the research questions asked (Mengist et al., 2020). The use of a framework in the form of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) can help and guide systematic reviews of research and reduce bias or tendencies by using systematic methods (Wu et al., 2018).

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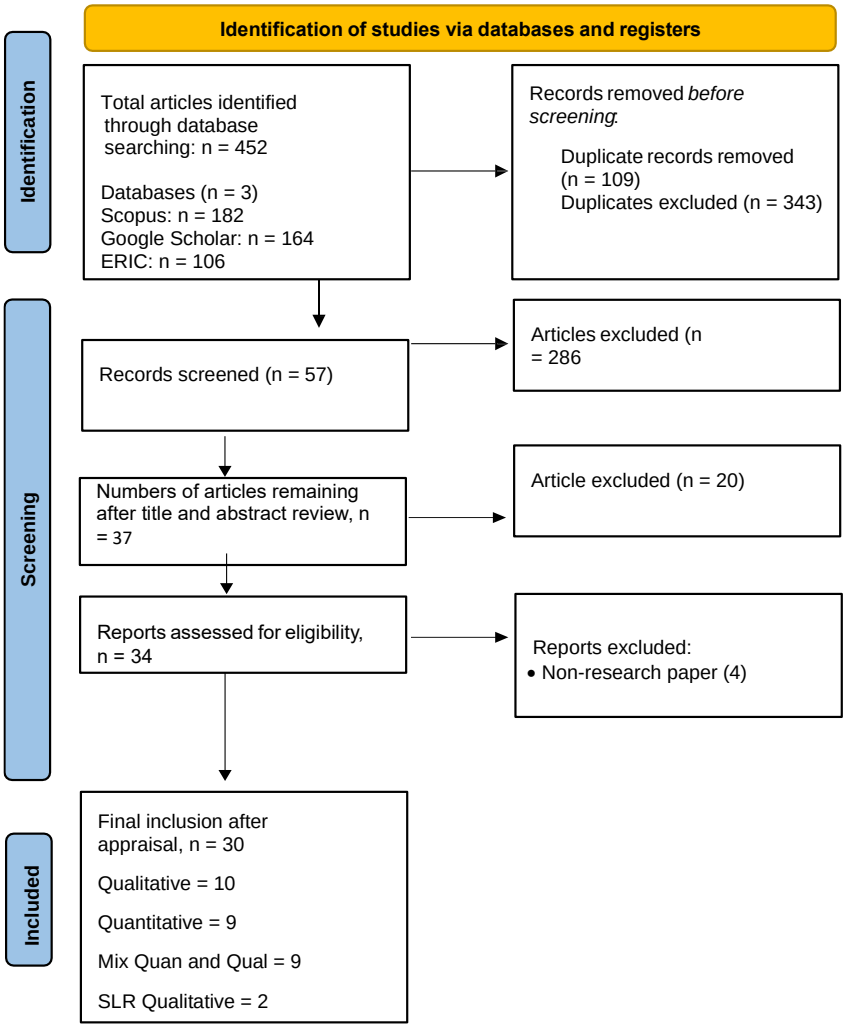

Figure 1: Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)

Search Strategy

Searches for reference sources were carried out using various sites including Scopus, ERIC and Google schoolar. To obtain relevant reference sources, a search strategy was formed in the form of using keywords. “Environmental Education” OR “Sustainable Education” OR “green education” OR “eco education” OR “climate” OR “biodiversity” AND “Science Classroom*” OR “science*” OR “biology” AND “Challenge*” OR “Barriers ” OR “Curriculum Alignment” OR “Teacher Training” OR “Comparative Studies” OR “Regional Variations” OR “Obstacles” OR “Educational Policy” OR “Global Perspectives” OR “Resource Constraints”.

Screening

A few criteria for evaluation and assessment are considered. First, related to literary genres, only journal articles with empirical facts that are verified indicate articles with a literary style, book spines, book chapters, book reviews, and conference proceedings that are not presented. Furthermore, in order to address constraints and difficulties in the research process, the focus of the study should only be on English-language articles rather than non-English publications. The third, which has to do with time constraints, is divided into five years (2019 to 2024), which is a suitable time frame to see how related research and publications have developed. As

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the review process focused on education leading to environmental education and the challenges faced by educators as well as various pedagogical applications in the implementation of environmental education, articles indexed in environmental science, published articles that were not in these fields were excluded. The article search was refocused by using keywords related to the topic and question statements, including environmental education, education, teaching and learning.

Table 2: Screening Technique

Criterion	Eligibility	Exclusion
Literature type	Journal (research articles and systematic review)	Book series, book, chapter in book, conference proceeding
Language	English	Non-english
Time line	Between 2019-2024	<2018
Indexes	Social Science Citation Index, Emerging Sources Citation Index, Art and Humanities Index (Web of Science)	Science Citation Indexed Expanded

Data Abstraction and Analysis

Analysis and evaluation were done on the remaining papers. A deliberate effort was made on certain research that addressed the issues posed. The needed data included responses to the study questions on the primary obstacles and difficulties faced by teachers when putting environmental education into practice, as well as cutting-edge pedagogical approaches and instructional techniques that have the greatest impact on environmental education. In order to discover relevant topics and sub-themes, the abstracts were reviewed first, followed by the entire articles (in-depth). Themes connected to environmental education techniques were found through qualitative analysis utilizing content analysis.

Result

The results of the review are presented in three major themes that are subdivided into several subthemes. The themes reflect the development of science classrooms towards environmental education. The themes consist of greening science classrooms, environmental education, challenges and barriers in implementing environmental education, innovative pedagogical strategies, and the development of environmental education teaching strategies that can be adapted by future learners. The results provide a comprehensive analysis of the implementation and development of greening the science classrooms.

Study Characteristic

A total of eleven studies focused on challenges and barriers to implementation of environment education (Eliyawati et al., 2023; Fajri et al., 2023; Fru & Ndaba, 2023; Huoponen, 2023; Marpa, 2020; Martínez Valdivia et al., 2023; Okada & Gray, 2023; Sofyan A Gani et al., 2023; Su & Zhao, 2023; Van Dijk-Wesselius et al., 2020; Waltner et al., 2020). There are fifteen studies focused on teaching method or pedagogical in implementation of environment education (Ecevit et al., 2020, 2020; Lin et al., 2023; Martínez Valdivia et al., 2023; Ricardo Barreto et al., 2022; Ustun & Tracey, 2021; Van Dijk-Wesselius et al., 2020; Zamora, 2023);(Butler, 2022; Hana Naqiyya Nada et al., 2021; Mahmud et al., 2020, 2020; Manzano-León et al., 2021; Matsekoleng et al., 2024; Nurwidodo et al., 2020; Ouariachi et al., 2020; Probosari & Nugraheni, 2021). And five studies explain about the environment education

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(Biancardi et al., 2023; Husamah et al., 2022; Maurer et al., 2020; Motevalli et al., 2022; Van Den Bogerd et al., 2020).

Furthermore, ten studies applied a qualitative approach while another nine studies used quantitative analytic methods. And there are nine studies employed a mixed methods (qualitative and quantitative) approach. And there are two studies used SLR qualitative analytic methods. Regarding years published, nine articles were published in 2020, four articles were published in 2021, four articles were published in 2022, twelve articles were published in 2023 and one artcile are published in 2024.

Environmental Education and Green Classroom

There are four articles found and used to review environmental education (Biancardi et al., 2023; Husamah et al., 2022; Maurer et al., 2020; Motevalli et al., 2022) and one article to review green classroom (Van Den Bogerd et al., 2020). Two articles using quantitative method (Maurer et al., 2020; Van Den Bogerd et al., 2020), one article using qualitative metode (Motevalli et al., 2022), one article using the combined method between qualitative dan quantitative (Biancardi et al., 2023) and one article using SLR qualitative method (Husamah et al., 2022). The results of the review broadly explain that environmental education is an educational system carried out with the ultimate goal that students and all school residents have knowledge and awareness of the environment. According to (Husamah et al., 2022) environmental education is an educational system that provides methods or programs, tools, and approaches that aim to support students to have knowledge, awareness, and behavior that leads to the environment. In (Maurer et al., 2020) explained that behavior that refers to the environment is closely related to factors outside of school such as the way parents educate, as well as the demographic factors of each student. (Motevalli et al., 2022) introduces another part of environment education, Education for Sustainable Development (ESD), which aims to strengthen individuals or students to have a mind that leads to a sustainable future, which can be implemented in various fields of life. (Biancardi et al., 2023) explained the importance of sustainability education, with the implementation of sustainability education can encourage students to have transformative innovations so that students can face complex problems in the future. In (Van Den Bogerd et al., 2020) said that environmental education is related to the green classroom. Green classroom that is meant by (Van Den Bogerd et al., 2020) incorporating biophilic elements into the learning space.

Challenges and Barriers When Implementing Environmental Education

This section concentrates on the challenges and barriers faced when implementing an education system that refers to environmental education. These challenges and barriers are divided into several sections including resource constraints, teacher training and curriculum allignment. The resource constraints section contains six articles (Fajri et al., 2023; Fru & Ndaba, 2023; Huoponen, 2023; Marpa, 2020; Sofyan A Gani et al., 2023; Van Dijk-Wesselius et al., 2020; Waltner et al., 2020), four articles explained about teacher training (Eliyawati et al., 2023; Marpa, 2020; Martínez Valdivia et al., 2023; Waltner et al., 2020), and five article explained about curriculum (Fru & Ndaba, 2023; Martínez Valdivia et al., 2023; Okada & Gray, 2023; Sofyan A Gani et al., 2023; Su & Zhao, 2023).

Resource Constraints

In implementing environmental education, one of the obstacles and challenges faced is resource constraints. The results of the review show that these obstacles can include constraints on

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individuals as teachers and students as well as constraints on facilities and infrastructure. According to (Marpa, 2020) stated that in integrating the environment, obstacles are faced in the form of the lack of instructional materials. In (Waltner et al., 2020) obstacles can be in the form of teaching materials that have not been well developed and follow the latest issues. Whereas according to (Sofyan A Gani et al., 2023) and (Fajri et al., 2023) said the obstacles were the lack of budget and the lack of collaboration between schools, government and society. In (Fru & Ndaba, 2023) that obstacles can be in the form of little time for teachers to provide practical environmental awareness to their students. And according to (Huoponen, 2023) obstacles can be the lack of students' environmental literacy level.

Teacher Training

Teacher training can also pose challenges and barriers to the implementation of environmental education. This is reflected in the review of four articles. According to (Marpa, 2020) The successful implementation of environmental education is based on the teacher training provided to teachers. Whereas in (Waltner et al., 2020) there is a need to improve teachers' knowledge and skills on Education Sustainability Development, which can be achieved through teacher training programs. This is strengthened in (Martínez Valdivia et al., 2023) which states that teacher training programs can prepare teachers' competencies in continuing education. In (Eliyawati et al., 2023) explained several teacher trainings programs that can be done to improve the quality of teachers including webinars, lecturig discussions, giving projects, experiments, workshops and field studies.

Curricula Alignment

The use of curriculum as a reference in the education system can also be an obstacle in the implementation of environmental education. According to (Martínez Valdivia et al., 2023) that the curricula used must be able to develop teacher competencies based on the principles in continuing education. This is strengthened in (Su & Zhao, 2023) which states that curriculum integration is closely related to the quality of education, and this is included in the green education setting that leads to the goal of sustainability education. It further states that the curriculum should aim to promote a sustainable future. Whereas according to (Fru & Ndaba, 2023) that the continuing education curriculum is only concentrated on final year students, so that the objectives of environmental education cannot be achieved optimally. (Sofyan A Gani et al., 2023) reinforcing the statement that the curriculum implemented in many schools may not allocate appropriate time for environment education so that the goal of integrating a sustainable environment will be difficult to achieve. (Okada & Gray, 2023) describes a framework that can be integrated into the environmental education curriculum, namely Care-Know-Do. In their article (Okada & Gray, 2023) explained that Cre-Know-Do is designed to teach students about Climate Change and Sustainability. It can strengthen students' knowledge of current environmental issues.

Innovative Pedagogical Strategies

This section contains various pedagogical strategies in the form of teaching methods, and various programs that can be used in implementing environmental education. There are fifteen studies that describe various pedagogical innovations that can be used in the implementation of environmental education. There are three main topics in this section, which consist of teaching methods used in nine articles (Butler, 2022; Ecevit et al., 2020; Mahmud et al., 2020; Manzano-León et al., 2021; Nurwidodo et al., 2020; Ouariachi et al., 2020; Ustun & Tracey, 2021; Van Dijk-Wesselius et al., 2020; Zamora, 2023), three articles explained about

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Adiwiyata program (Hana Naqiyya Nada et al., 2021; Nurwidodo et al., 2020; Probosari & Nugraheni, 2021;), and three articles reviewed about incorporating technology in environmental education practices (Jardin, n.d.; Lin et al., 2023; Ricardo Barreto et al., 2022).

Teaching Method

Teaching method is a method used in the learning system so that learning can be carried out properly and achieve the ultimate goal of learning. There are many teaching methods that have been used by teachers and adapted to the topic and learning objectives to be achieved. In learning environment education and or sustainability education has been widely studied. In (Van Dijk-Wesselius et al., 2020) explaining that one of the methods suitable for environmental education is outdoor learning or field trips, this method concentrates on direct teaching of the environment so that it can spur students' awareness of their environment. Another method is CSL or Community Service Learning in the study of environmental education (Zamora, 2023), The results of his study explain that this method can raise awareness and increase student engagement that leads to a sustainable environment. (Ustun & Tracey, 2021) explained another pedagogy, Blended Learning, according to his study that the Blended Learning method can increase collaboration and student engagement leading to a sustainable environment when combined with self-regulation. While the study by (Butler, 2022) suggested Hands-on Learning method for teaching environmental education, this is because it can increase students' active engagement and real world relevance and skill development. According to (Ecevit et al., 2020) Another method mentioned is the constructivist approach, which emphasizes the active role of students in building their understanding related to the environment. Problem Based Learning (PBL) is also suggested as a teaching method in environmental education (Nurwidodo et al., 2020). Meanwhile in (Mahmud et al., 2020; Manzano-León et al., 2021; Matsekoleng et al., 2024; Ouariachi et al., 2020) explain the gamification method in teaching environmental education so as to create a fun learning atmosphere.

Adiwiyata Program (Green School Initiatives)

Adiwiyata program is a learning program offered by the Indonesian government as a means of implementing sustainable environment-based education. According to (Probosari & Nugraheni, 2021) explained that the implementation of the Adiwiyata program faced challenges in the form of difficulties experienced by teachers when providing stimulation to students to have high order thinking skills related to the environment. In (Hana Naqiyya Nada et al., 2021) explained the strategies used in the implementation of the Adiwiyata program, including developing environmental innovations that can attract school members to be involved in environmental conservation. In addition (Nurwidodo et al., 2020) explained the positive impact of implementing the Adiwiyata program in schools.

Integration of Technology in Implementing Environmental Education

The use of technology is considered quite important as a means of delivering and implementing environmental education. The use of technology can support programs and methods used in environmental education or sustainability education. In a study conducted by (Ricardo Barreto et al., 2022) mentions the use of the type of technology in the form of Information and Communication Technologies (ICTs), educational platforms, web 2.0 resources, mobile applications (Apps), and virtual reality. In (Jardin, n.d, 2023) describes the use of AR in encouraging student engagement in interacting with ecosystems. And in the study by (Lin et al., 2023) explain the use of AI and IT in training Eco-Friendly and personalized learning experiences.

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Discussion

This study has attempted to systematically analyze the existing literature on Greening the Science Classroom review of Environmental Education Practices. Greening the classroom that leads to environmental education is needed now and will continue to be studied for a sustainable future. Environmental education is a series of educational systems that are created, developed and run with the aim of producing and individual who has high knowledge and respect for the environment and nature. A systematic review of this study was conducted using 3 database sources that produced 30 articles related to environmental education practices. The results show a variety of variations in the implementation of environmental education, from the 30 articles obtained there are articles that present various challenges and obstacles to the implementation of environmental education. While other articles present the results in the form of programs in the implementation of environmental education which also includes teaching methods.

The study is divided into 3 themes and 6 subthemes that are specifically explained. Based on the review of selected artciles, several points were highlighted on the development and implementation of environmental education in various countries. The review is divided into the main theme, namely an overview of greening the classroom, and various challenges, obstacles in the implementation of environmental education as well as a discussion of the implementation of environmental education.

In the implementation of the environmental education system, it was revealed that there are quite a number of challenges and obstacles faced by the parties involved in an education system. Most reviews revealed that the challenges come from a variety of sources such as curriculum issues (Fru & Ndaba, 2023; Martínez Valdivia et al., 2023; Sofyan A Gani et al., 2023; Su & Zhao, 2023), low resources such as lack of teaching experience (Marpa, 2020), to the lack of facilities and the low literacy of students towards environmental learning (Huoponen, 2023). These challenges and obstacles can certainly disrupt the environmental implementation process so that the goals to be achieved are not successful or not optimal. It is necessary to review these challenges and obstacles, including by analyzing the curriculum used, it is necessary to change and develop the curriculum so that it can be used for the implementation of environmental education. Changes to the curriculum will certainly change a lot of the education system that is carried out (Muhammad Dicky Darmawan & Dagamac, 2021). And of course, other obstacles such as the lack of teacher skills can be improved and enhanced by teacher training efforts, which can be provided in the form of workshops and webinars (Eliyawati et al., 2023).

To smoothen the implementation of environmental education, many articles reveal various innovative pedagogical strategies that contain programs and methods that can be used. Many articles suggest using the gamification method because it is felt that it will create a fun learning atmosphere. So that students can easily receive lessons well. The review of various articles mentioned several games that can be used including JouleBug (Mahmud et al., 2020), meanwhile (Ouariachi et al., 2020) mentions 6 other types of games including. In addition to the use of games during the learning process, other articles mention the importance of the involvement of technology, including AR, AI and IT (Lin et al., 2023). And another article mentions the use of different types of databases that can help learners (Ricardo Barreto et al., 2022). Many articles also mention other teaching methods that can be used among contructivist (Ecevit et al., 2020), PBL (Nurwidodo et al., 2020), hands-on learning (Butler, 2022), and

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fieldtrip (Van Dijk-Wesselius et al., 2020). The review shows that these approaches in the learning system are proven to increase students' knowledge and awareness towards environmental sustainability. In addition, this type of learning is more effective because it stimulates students' higher-order thinking and student centered learning.

More specifically, in the review of several articles, one of the environmental education programs that has been implemented in Indonesia is the Adiwiyata (Greening school) program. Several articles mention that this program was developed by the Indonesian government as a manifestation of public awareness of the deteriorating global environment. The Adiwiyata program will certainly create future individuals who have awareness and behavior that respects nature and the environment. And so on, this program must continue to be developed and implemented in many schools in Indonesia and even in schools in other countries, so that more individuals will have good environmental awareness.

The Adiwiyata program sounds very tempting to continue to be developed and can be used by many schools. The right strategies are needed to be able to develop this education program. Improvements and performance enhancements can be made such as reviewing the curriculum to be used, the methods to be used to assess the desired goals or outcomes. Reviewing the curriculum used is crucial and important, because the curriculum is the axis used as a guide in this program. The curriculum must take into account the appropriate time and teaching materials at each level of education. It is also necessary to analyze teaching methods and approaches that are tailored to the type of material and educational level of each student. So that with this improvement and quality improvement, it is hoped that the Adiwiyata program and other greening school programs can be more qualified and triumphant to create smart individuals who can handle all current and future world problems.

Conclusion

This systematic review presents information related to greening the science classroom which includes a discussion of the implementation of environmental education with a more specific discussion of the barriers to implementation. Challenges and barriers can include a lack of resources such as money and teaching infrastructure. Barriers can also stem from a lack of training for teachers. And a crucial obstacle can also come from the development of a curriculum that is still not optimally used to teach environmental education materials. In addition, this study also features programs and pedagogies that can be used during the implementation of environmental education. The pedagogy displayed is quite diverse ranging from those that can be implemented indoors, outdoors and even online. And this study also features one of the greening school programs implemented in Indonesia, namely the Adiwiyata program. Greening classroom that leads to environmental education is needed now and will continue to be studied for a sustainable future. The results of the review and assessment of various literature reviews are summarized in this study which are relevant to greening classrooms and environmental education. So that from the information contained in this study can be knowledge of the picture to face the present and the future.

Strength and Limitations

This study is one of the studies that presents the results of a literature review carried out with rigorous and well-structured steps. By using a structured methodology so as to produce a good form of study. In addition, this study uses relevant literature sources and goes through a good selection process so that only relevant articles are selected. The selection of various literature

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sources was done by following agreed and high quality requirements. In addition, the results shown in this study successfully cover and answer the research questions. Therefore, the information presented is very detailed and can serve as a reference source for future research. In addition, there were limitations and obstacles encountered during the study, including the difficulty in finding suitable literature sources, and the selection process took a lot of time.

Future Research Directions

This study is sustainable, which means that it still needs to be developed in the future, this can also be seen from the ascending graph shown in the literature source search database such as SCOPUS. Future studies may be able to examine more time spans, because this study only examines the implementation of environmental education programs between 2018-2024. It is also necessary to add articles used in the research, and need to be selected more specifically. In addition, future research can continue the gaps that exist in this study. These gaps can be in the form of the development of the Adiwiyata program, which in this study has not been studied in great depth. In addition, future research can examine more about learning strategies that are more impressive and of course adapted to the needs of society in the future.

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