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A Systematic Literature Review on Sustainability Awareness: How Does It Contribute to Science Education

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Abstrak

Tujuan : mempelajari informasi dasar melalui studi sistematik literatur yang membahas peran kesadaran keberlanjutan dalam meningkatkan pemahaman siswa tentang konsep-konsep biologi dan memberikan informasi terkini terkait hasil penelitian kesadaran berkelanjutan (*sustainability awareness)* serta bagaimana kontribusi nya terhadap Pendidikan biologi **Metode**: Data dikumpulkan dengan mencari sumber-sumber literatur untuk artikel-artikel yang menggunakan kriteria tertentu. Lima belas artikel disintesis secara lebih mendalam untuk menjawab pertanyaan-pertanyaan dari penelitian yang dilakukan. **Hasil** dari penelitian ini menyatakan bahwa metodologi dan alat penilaian mempengaruhi bentuk dan tujuan data penelitian yang ingin dicapai baik secara kualitatif maupun kuantitatif. Selain itu konsep dalam Pendidikan biologi sangat berkaitan dengan lingkungan sehingga sangat penting untuk memastikan bahwa generasi mendatang memiliki pemahaman yang kuat tentang isu-isu keberlanjutan dan dapat berkontribusi pada Pembangunan berkelanjutan di Masyarakat dengan kesadaran keberlanjutan untuk dapat mencapai tujuan berkelanjutan. **Kebaruan** : Dalam meningkatkan kontribusi Pembangunan berkelanjutan perlu difasilitasi bahan ajar maupun strategi belajar menarik agar dapat mengimplementasikan ESD. Proses pembelajaran memiliki peran yang penting dalam mendukung peningkatan pemahaman kuat tentang kesadaran berkelanjutan. Bisa dilakukan dengan pendekatan *mix method* agar penelitian lebih komprehensif.

Kata Kunci: Kesadaran Keberlanjutan, Pendidikan Biologi, Tinjauan Pustaka Sistematis, Bibliometrik

Abstract

Objective : Sustainability awareness has become an important topic in education, particularly in biology, where understanding ecosystems and human interactions with the environment is a major focus. This article reviews existing literature to explore how sustainability awareness contributes to biology education. This review aims to identify and analyze literature that addresses the role of sustainability awareness in improving students' understanding of biology concepts and promoting sustainable practices. Methods: Data was collected by searching literature sources for articles using specific criteria. Fifteen articles were synthesized in greater depth to answer the research questions. The results of this study state that the methodology and assessment tools influence the form and purpose of the

research data to be achieved both qualitatively and quantitatively. In addition, the concepts in biological education are closely related to the environment so it is very important to ensure that future generations have a strong understanding of sustainability issues and can contribute to sustainable development in society with sustainability awareness to be able to achieve sustainable goals. Novelty: In increasing the contribution of sustainable development, it is necessary to facilitate interesting teaching materials and learning strategies in order to implement ESD. The learning process has an important role in supporting the improvement of a strong understanding of sustainability awareness. Can be done with a mixed method approach to make the research more comprehensive.

***Keywords**: Sustainability Awareness, Biology Education, A Systematic Literature Review, Bibliometric*

A. Introduction

The concept of sustainability awareness is becoming increasingly important in education, particularly in the field of biology. As educators strive to instill an understanding of environmental interconnections and their implications for health among students, integrating sustainability into biology curricula has emerged as a significant pedagogical strategy. This literature review synthesizes contemporary research to explore how sustainability awareness contributes to biology education. Concepts in biology education are closely related to the environment, so it is essential to ensure that future generations have a strong understanding of sustainability issues and can contribute to sustainable development in society with sustainability awareness to achieve sustainable goals. Biology education is a key pillar in enhancing students' environmental awareness and health literacy. The biology curriculum plays an important role in increasing students' environmental awareness and health literacy. It is predicted that students will become knowledgeable global citizens with the ability to address pressing ecological issues (Bara et al., 2024). In line with Zarar's statement, incorporating sustainability principles into the secondary school biology curriculum can improve curriculum structure and coherence, resulting in a structured educational framework that promotes ecological literacy (Bara et al., 2024). Together, these studies show that a well-designed biology curriculum can not only help students achieve their academic goals but also encourage them to contribute to sustainability.

Formal and informal education are very important for raising environmental awareness and understanding of sustainability issues among students. (Atmaca et al., 2019; Noordin et al., 2010). With continuous awareness among each student, it is certain that future generations will understand global issues and hopefully be able to contribute significantly to sustainable development. The importance of Education for Sustainable Development (ESD) in overcoming various environmental problems (Ekamilasari et al., 2021). In addition, integrating sustainability into biology education encourages critical thinking and problem-solving skills as students engage with real-world issues. Fleacă et al. state that embedding principles of education for sustainable development across all levels of education, including biology, enriches students' engagement and satisfaction with the learning process (Fleaca et al., 2023).

The practical approach adopted by Jackson et al. addresses sustainability in high school biology classes through socio-scientific issues that foster students' personal growth and their relationship with the challenges of community life, which in turn emphasizes the importance of critical engagement in sustainability topics (Jackson et al., 2023). These efforts not only raise awareness but also empower students to become active participants in sustainability initiatives.

Sustainable development goal number 4 is Quality Education, The goal focuses on education to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all." Among its targets, 4.7 emphasizes the need for learners to acquire knowledge and skills to promote sustainable development, including sustainable lifestyles and behaviors. As such, Education for Sustainable Development (ESD) is an integral part of SDG 4 and recognized as a key catalyst for other SDGs (United Nations, 2019). Because the greatest and most important developments in a person's life occur during childhood, and these developments are considered to be the foundation that builds the rest of their lives (Rutter, 2002), Environmental/sustainability education should begin at an early age so that it can be learned throughout life and become a responsibility to apply it in a conscious and sustainable manner.

Various factors contribute to the effectiveness of sustainability awareness in education. Setiawan et al. conducted a study showing that gender influences environmental knowledge and sustainability awareness, suggesting that tailored educational approaches may improve learning outcomes in different student populations (Setiawan et al., 2023). Similarly, Lace-Jeruma and Birziņa explored how *eco-school* initiatives significantly increased students' environmental awareness through targeted biology lessons, demonstrating the effectiveness of active learning environments in fostering sustainability awareness (Lace-Jeruma et al., 2019). This synergistic relationship between pedagogical methods and student engagement ensures deeper understanding and commitment to sustainable practices. Growing research and statements about the importance of systemic thinking in fostering sustainability awareness are also highly relevant. Palmberg et al. argue that systemic thinking enables students to understand the complex relationships between biodiversity, species identification, and sustainable development, thereby enhancing their critical thinking skills related to environmental issues (Palmberg et al., 2017). This approach is in line with the push for interdisciplinary education that integrates various educational outcomes aimed at achieving sustainable development goals

(Kioupi & Voulvoulis, 2019). Even though interest in sustainability education is expanding, there is still a lot to learn about the current trends influencing sustainability consciousness, especially across various educational contexts and levels. Although sustainability integration in curricula has been studied in the past, few studies have thoroughly examined new trends including the influence of digital tools, interdisciplinary methods, or local versus global sustainability viewpoints on raising awareness. This research is unusual because it takes a comprehensive approach to detecting and evaluating trends and influencing factors, giving

educators and policymakers a better road map. This study provides new insights into how sustainability awareness develops and identifies creative ways to increase it by combining global and regional viewpoints.

Another role in fostering sustainability awareness can come from communities focused on promoting the importance of sustainability. Observations from recent studies show that collaborative projects, such as aquaponics systems, have the potential to teach students real-world applications of biology while fostering a sustainable mindset (Ogodo et al., 2023). By participating in this community-based initiative, students develop practical skills that empower them to contribute positively to their environment in the future. The specific objectives of this study are to examine basic information through a literature review that discusses the role of sustainability awareness in improving students' understanding of biological concepts and to provide the latest information on the results of research on sustainability awareness and its contribution to biology education. Several questions must be answered based on this background. This study aims to answer two important questions: first, it seeks to understand the current trends in the development of sustainability awareness in education, examining how educational institutions and curricula are evolving to incorporate sustainability principles. Second, it investigates the main factors that influence the development and improvement of sustainability awareness, exploring the role of policy, pedagogy, community engagement, and other drivers in fostering a deeper understanding of sustainability among learners. By addressing these questions, the study aims to provide insights into how sustainability awareness can be effectively promoted and strengthened in educational contexts.

B. Research Method

In analyzing this study, we used a systematic review approach by applying the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework. (Gough & Thomas, 2016). The articles analyzed were obtained from the main academic database, namely Scopus. Each article was analyzed based on the suitability of the method, the accuracy of data collection, and relevance to the topic of sustainable awareness in education. This analysis ensures that the findings presented are supported by strong and reliable empirical data. In addition, Vosviewer and R studio were used to analyze research trends. The search process was conducted using specific keywords, such as “sustainable awareness,” “education,” “science,” and “contribution,” to ensure relevance to the research topic. To ensure the validity and quality of the articles, this study established inclusion and exclusion criteria. (Demaerschalk et al., 2016; Petersen et al., 2015). Scopus has a more inclusive policy than some other databases, meaning not all its content will appear elsewhere. Researchers should check multiple databases for comprehensive literature reviews. Inclusion criteria include articles focusing on formal education, published between 2015 and 2025, and based on empirical studies using qualitative,

quantitative, or mixed methods with a TITLE-ABS-KEY document search (*sustainability* AND *awareness* AND *in* AND *science* AND *education*). These criteria use three stages of analysis, namely identification, screening, and eligibility. In the Identification stage, article data were collected from the Scopus database, with a total of 641 articles identified. However, 132 articles published before 2015–2025 were excluded from the analysis. Next, in the Screening stage, the identified articles were screened, reducing the number to 509 articles. From this screening, 388 articles were excluded because they did not meet certain criteria, such as not being the type of article or being a book chapter, not being written in English, being a review article, or not being relevant to the field of education. In the Eligibility stage, from the remaining 111 articles, only 38 articles met the specified criteria. These articles were considered relevant to the research topic, written in English, original research articles, and published within the appropriate time frame (2015–2025). Therefore, these 38 articles were accepted for further analysis as they met all the required inclusion criteria. Figure 1 shows the flowchart of this study**.**

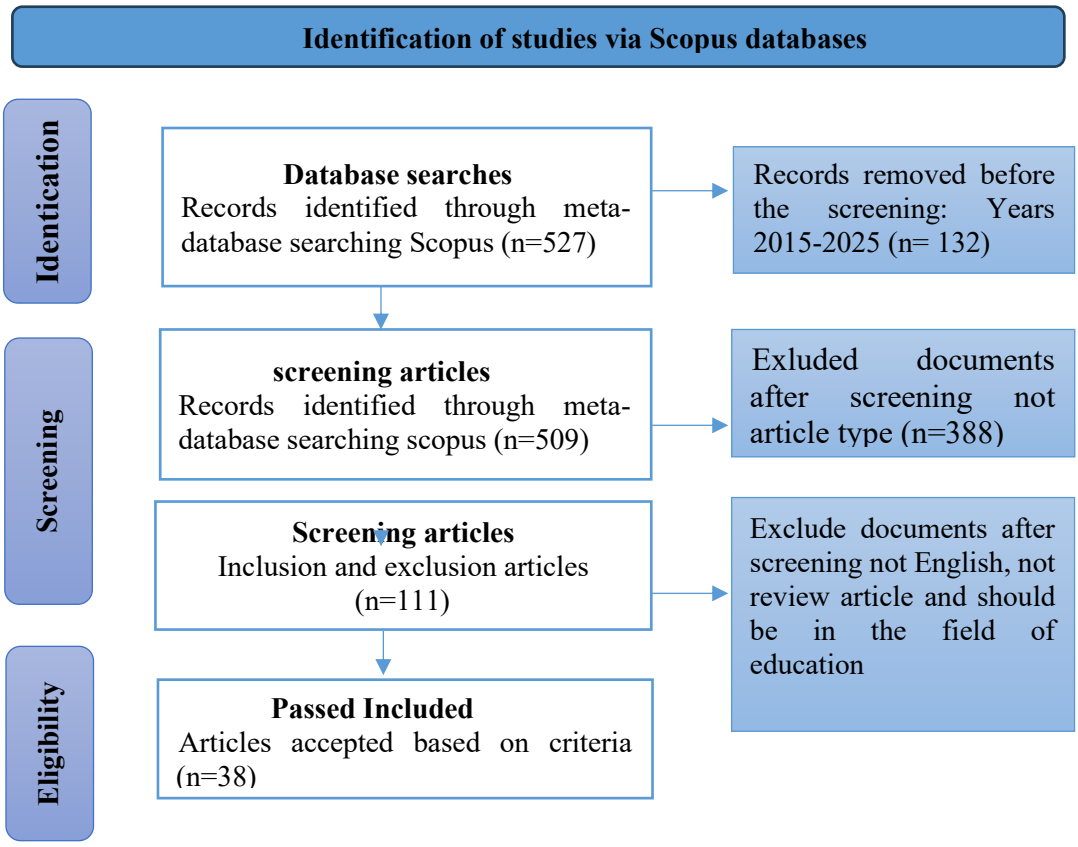

Figure 1. Prisma Methods Flow Diagram *(https://www.prisma-statement.org/prisma-2020-flow-diagram)*

Based on Figure 1, included obtained 38 articles to be analyzed and expected to answer important questions in line with the research objectives. The results will be discussed after analyzing the articles that have been screened using the prism method.

C. Research Results and Discussion

1. Current Trends in the Development of Sustainable Awareness in Education

1.1 Trends in the number of publications in *Sustainability Awareness*

The results of the analysis of publications in the Scopus database for the period 2015-2025 in various scientific journals worldwide regarding sustainable awareness at the screening stage can be seen in Figure 2. Number of articles per year

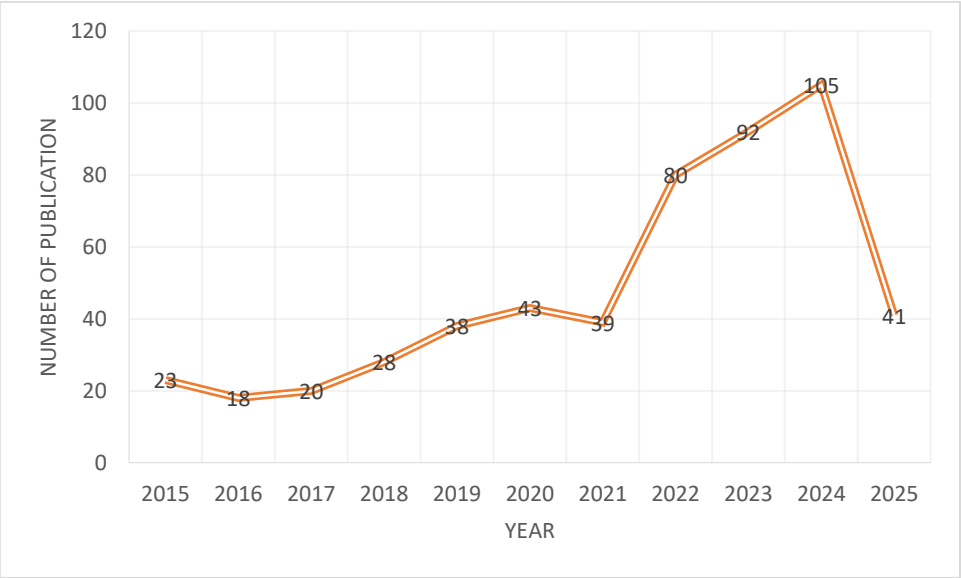

Figure 2. Document Per Year About Sustainability Awareness

Based on Figure 2, the trend of publications in the field of sustainability has experienced a fairly dynamic development in recent years. Since 2015, the number of publications in this field has tended to increase gradually, although there was a decline in 2016. At the beginning of the period, the number of publications was still relatively low, around 23 documents, with a slight decrease in 2016 to 18 documents. However, the trend began to show a steady increase until 2021. Significant momentum occurred in 2022, where the number of publications increased sharply compared to the previous year, increasing to 41 documents. This surge continued until it peaked in 2024, with almost 105 documents published.

However, the trend in 2025 shows a decrease, with 41 documents recorded. This decrease is probably due to two main factors. Firstly, the year 2025 has only just begun until May this year, so publication data has not yet been fully recorded. Secondly, it is possible that the focus of research has shifted or that there are limits to the number of publications that can be produced in the early years. The publication trend in the field of sustainability shows a significant growth pattern over the last decade, with the highest performance in 2024. In specific areas like sustainable consumption, green marketing, and tourism, publication rates have grown steadily, with notable surges in recent years (Kar & Harichandan, 2022; Niñerola et al., 2019). Research in the field of sustainability has experienced significant and accelerating growth over the past decade, with publication numbers reaching their highest levels in recent years. This trend reflects increasing global attention to sustainability issues across multiple disciplines. Interdisciplinary approaches are increasingly common, with frequent use of keywords like "sustainable energy," "renewable energy," "sustainability," and "sustainable development" (Abad-Segura et al., 2020; Kemeç & Alt\inay, 2023; Olawumi & Chan, 2018). Sustainability awareness contributes to science education by fostering critical scientific literacy, enabling learners to navigate diverse perspectives on sustainability issues. The study highlights that while sustainability themes are present in some modules, the focus often remains on technical knowledge rather than critical exploration. This awareness encourages students to engage with real-world challenges, promoting transformative educational experiences that align with the United Nations Sustainable Development Goals, ultimately preparing them to contribute to a more sustainable world ((Hogan & O'Flaherty, 2021).

1.1.2 Publication trend country

The results of the analysis of the countries that published the most publications in the Scopus database, both in journals and proceedings related to sustainable development in the 2015-2025 period, can be seen in Figure 3.

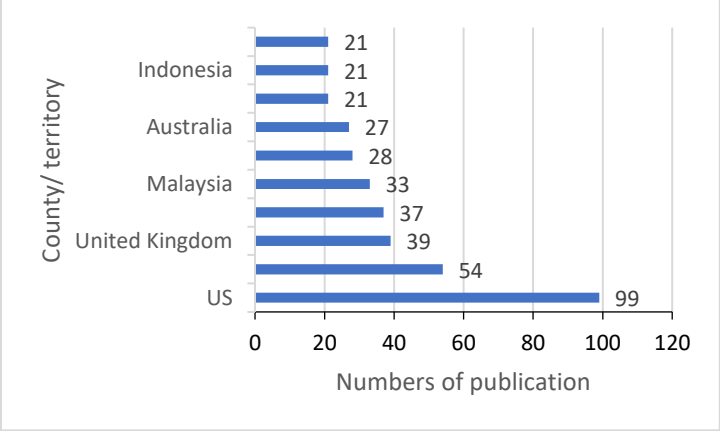

Figure 3. Document by Country or Territory

Based on Figure 3, in recent years, research on sustainable development awareness has experienced rapid growth in various countries, with the US emerging as the leader in terms of the number of publications. Based on the data presented, Indonesia recorded 21 publications, while the US, with 99 publications, dominated the theme of sustainable development in this study, reflecting the growing attention to sustainable awareness in education, innovation, and academic policy in that country. On the other hand, the United States remains one of the main contributors to sustainable development research, likely due to its exploration of sustainable awareness in higher education, technology, and 21st-century skill development. The research indicates that there has been a significant increase in publications related to sustainable lifestyles and awareness from 2005 to 2023, highlighting dynamic developments in this field. While the paper emphasizes global collaboration among countries, it does not specifically identify the US as the leader in the number of publications. Instead, it focuses on the contributions of leading authors and institutions, underscoring the importance of a comprehensive approach to address climate change and promote sustainable development globally (Napasti et al., 2024).

1.1.3 Trend Documents Source Per Year

The analysis of documents per year by source in the field of sustainability reveals a dynamic and evolving landscape, with significant contributions from various journals, countries, and institutions. The journal "Sustainability" emerges as a leading source, reflecting its prominence in the field. The data from multiple studies highlight the growth in publications related to sustainability, driven by interdisciplinary collaboration and international contributions. This overview will delve into the key sources, geographical distribution, and institutional affiliations contributing to the sustainability literature.

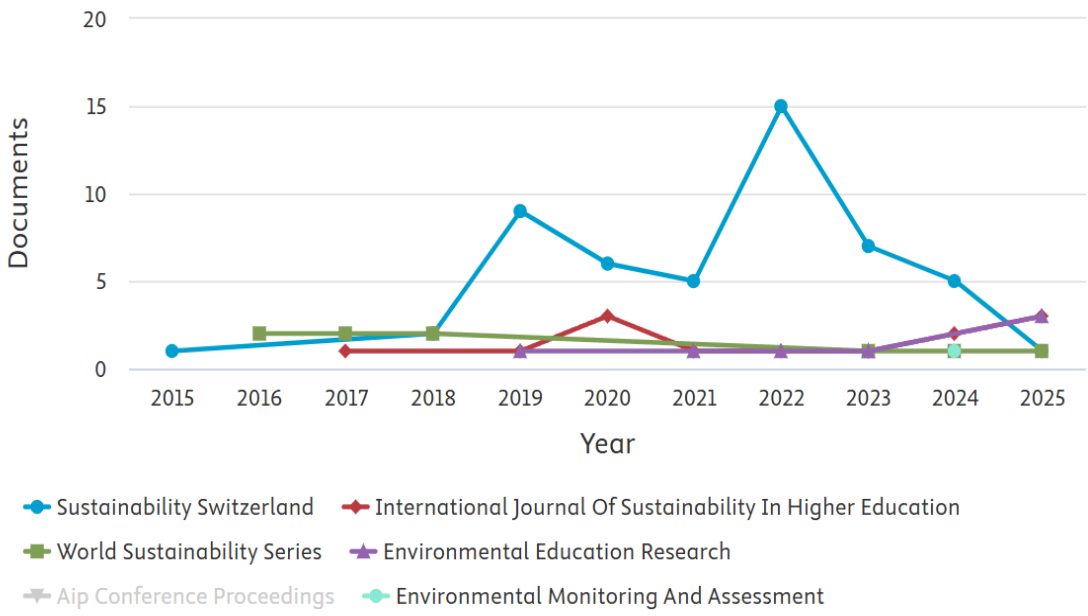

Figure 5. Documents per year by source

In **Figure 5.** "Sustainability Switzerland" can be addressed by examining the trends in academic publications related to sustainability. The journal "Sustainability Switzerland" is identified as a dominant source for documents related to Sustainable Development Goals (SDGs) and socio-sustainability topics, indicating its significant role in disseminating research in these areas. This prominence is reflected in the increasing number of documents published annually, particularly in the fields of environmental science, energy, and social sciences. "Sustainability Switzerland" is highlighted as the leading source for documents related to sustainability, surpassing other journals such as the International Journal of Sustainable Development and World Ecology (Halim et al., 2023).

1.1.4. Overlay Visualization

A bibliometric analysis technique called overlay visualization is used to show how different concepts or subjects in a field of study relate to one another (Huang et al., 2017). This image allows us to observe the relationships between concepts as well as the evolution and dissemination of research subjects across time. This map's colors correspond to the term's emergence timeline; older colors denote themes that have been studied for a long time, while newer colors denote topics that are only starting to be explored. Overlay representation in Figure 6 will assist in recognizing both possible future research directions and current research trends.

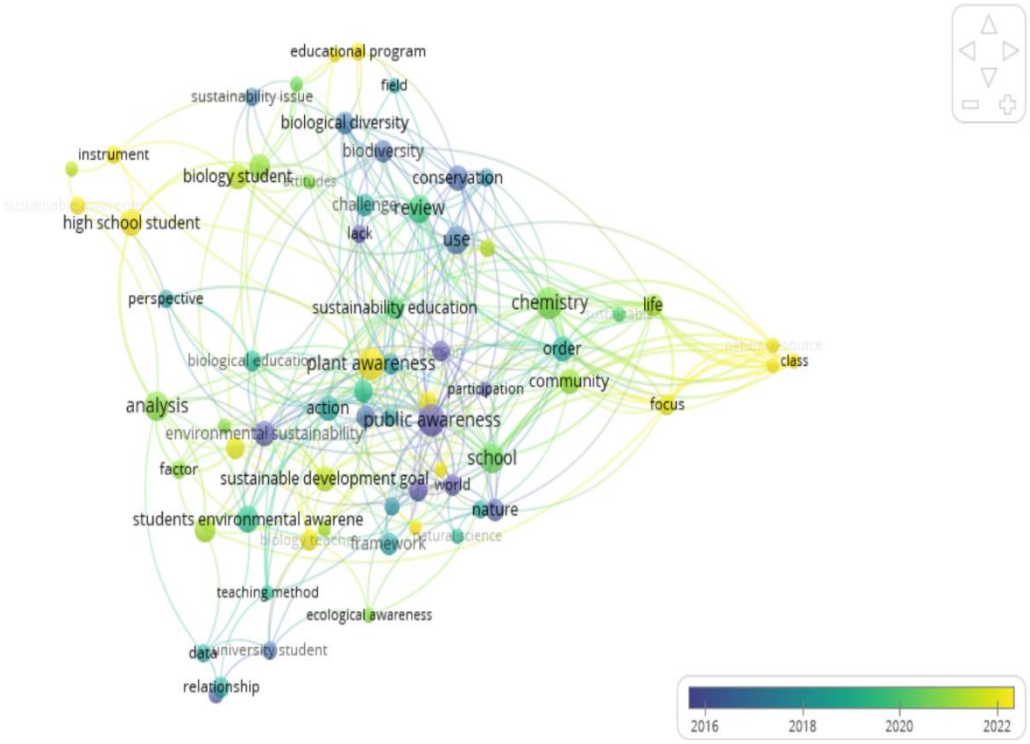

Figure 6. *Overlay Visualization of sustainability awareness*

The explanation of Figure 6, titled "Overlay Visualization of Sustainability Awareness," involves understanding how visual tools can enhance the comprehension of sustainability issues, particularly in urban environments. This figure likely represents a complex visualization that integrates various data points to highlight sustainability awareness. The visualization aims to make invisible aspects of sustainability visible, thereby aiding designers and the public in understanding and addressing sustainability challenges. The following sections will delve into the key aspects of this visualization.

Overlay visualization of sustainability awareness involves superimposing various data layers to illustrate complex relationships and trends related to environmental issues. This technique enhances understanding by combining different datasets, such as carbon emissions, energy

consumption, and biodiversity metrics, allowing viewers to see how these factors interact. By utilizing interactive elements, users can explore scenarios and make informed decisions, fostering greater public awareness and engagement in sustainability efforts. This approach aligns with the workshop's goal of empowering stakeholders through effective data visualization (Bach et al., 2024).

In the figure starting from 2022, there are many links between sustainable awareness and sustainable development, especially in the environmental field, through overlay visualization we can recommend research “gaps” that can be developed. There are not many connections between topics other than the environment, especially the physiology of the human body and sustainability awareness. Future research can begin to be carried out for content that can help life to have sustainability awareness.

2.1. Main Factors That Influence The Development And Improvement Of Sustainability

Sustainability awareness is a multifaceted concept influenced by various factors, including education, corporate actions, socio-psychological elements, and historical milestones. These factors collectively shape the understanding and engagement of individuals and organizations with sustainable practices. The development and improvement of sustainability awareness are crucial for fostering sustainable development across different sectors and communities. Below are the main factors that influence sustainability awareness, as derived from the provided research papers.

Education is a fundamental driver of sustainability awareness. Higher education institutions play a pivotal role by integrating sustainability into their curricula, scientific production, and infrastructure policies. This integration helps develop sustainability thinking among students, equipping them with the necessary skills and knowledge to address sustainability challenges (Lopes et al., 2018). ESD is a critical component of science education, aiming to equip learners with the skills and knowledge needed to address sustainability challenges. ESD-based teaching materials have been shown to significantly enhance students' critical thinking, problem-solving abilities, and sustainability awareness. The integration of ESD into science curricula is essential for promoting sustainable development and improving education quality, particularly in regions prone to environmental challenges (Sihombing et al., n.d.). The literature review highlights the significance of Education for Sustainable Development (ESD) in science education, emphasizing its role in fostering sustainability awareness among students. ESD integrates economic, social, and environmental dimensions, which are crucial for achieving Sustainable Development Goals (SDGs). By utilizing ESD-based learning applications, educators can effectively engage students in sustainability issues, enhancing their understanding and commitment to sustainable practices. This integration is essential for developing informed citizens capable of addressing contemporary environmental challenges (Sunarya et al., 2024).

Table 1. Summary of Research Analysis Results with teachers as participants on Sustainability Awareness

Authors and Year	Research Questions or Focus	Sample	Methods	Key Findings Related to Sustainability Awareness
Anna Uitto and Seppo Saloranta (2017)	Sustainability education (SE) is included in school curricula to integrate the principles, values, and practices of sustainable development (SD) into all education.	442 subject teachers from 49 schools in Finland.	A survey method. This study investigates lower secondary school subject teachers as educators for sustainability.	The teacher's subject was the most important factor explaining teachers' contribution to sustainability teaching (ST) , while their age had little importance.
Enkelejda Bara1 et al (2024)	The biology curriculum significantly shapes students' understanding of health and environment, equipping them with knowledge and skills necessary for responsible citizenship and informed decision-making.	The sample consists of 200 students and 20 teachers. The research instruments used for the collection of data were questionnaires, interviews, and classroom observation.	The study utilized a mixed-methods research design.	The study shows the important role instructors play in the curriculum acts as a catalyst for bringing important health issues, like disease prevention and individual well-being, to the public's attention while simultaneously encouraging a sense of responsibility for the sustainability of the environment and the preservation of our world.
Ekamilasari et al. (2021)	Education for Sustainable Development (ESD) is very important for environmental utilization while protecting environmental conditions. Therefore, learning needs to facilitate students to have sustainability awareness and critical thinking skills.	213 students and six teachers of junior high school in Bogor municipality.	The method used was descriptive quantitative and qualitative.	ESD should increase students' sustainability awareness and critical thinking skills. Sustainability awareness and students' critical thinking skills are very important to solve environmental problems.

Based on Table 1, with keywords related to sustainable awareness in teachers, it shows that the subject taught by teachers is the most important factor in promoting sustainable learning (ST) to instill sustainable awareness, while the age of teachers has no significant effect. This indicates that expertise and the relevance of learning materials are more influential than teaching experience alone. Additionally, teachers' roles in the curriculum are crucial as catalysts in addressing important issues such as disease prevention, individual well-being, and responsibility toward environmental sustainability. By integrating sustainability topics into learning, teachers not only raise public awareness but also foster a sense of collective responsibility for protecting the earth. Education for Sustainable Development (ESD) should also focus on increasing students' awareness of sustainability and critical thinking skills. Both aspects are considered essential in equipping young people to understand and solve environmental problems. Through an effective ESD approach, students can develop analytical skills and innovative solutions to sustainability challenges while forming a more responsible mindset toward the future of the planet. Therefore, the education system must strengthen the integration of sustainability principles and environmental literacy into the curriculum to create competent and caring agents of change for global sustainability. In addition to teachers, there have been many studies that used students as the object of research in table 2.

Table 2. Summary of Research Analysis Results with students as participants on Sustainability Awareness

Authors and Year	Research Questions or Focus	Sample	Methods	Key Findings Related to Sustainability Awareness
Xinqun Yuan (2021)	Investigate senior high school students' awareness of the Sustainable Development Goals (SDGs)	The sample consisted of 328 senior high school students, all from the International Department of Beijing No.35 High School in Beijing, China	A questionnaire survey was the primary research method used in the study	The research underscores the importance of improving sustainability education among high school students in China, highlighting both the current gaps in knowledge and the potential for growth through enhanced educational practices.
Elisa Saraiva (2024)	There is a consensus that the content of education for sustainability should be integrated into the curriculum, engaging students in activities that promote	The activities that lead to this case study were developed during the school year of 2020/2021 and involved thirty-nine 8th grade students (21 male and 18 female) from a public low secondary school.	These triangulation approaches enhance reliability of the research findings and provide a more comprehensive understanding. By combining qualitative (content analysis) and quantitative (self-	These findings underscore the need for a more balanced approach in science education that not only imparts technical knowledge but also encourages critical exploration of sustainability issues. This

Authors and Year	Research Questions or Focus	Sample	Methods	Key Findings Related to Sustainability Awareness
	awareness and practice of sustainability.		assessment and questionnaires) approaches.	balance is essential for fostering a deeper understanding and awareness of sustainability among future educators.
Guadalupe et al. (2019)	The framework of sustainable development encompasses a series of behaviours which include the proper management of the waste we produce..	The sample consisted of 72 secondary school teachers in training belonging to three scientific technological areas (Physics & Chemistry, Biology & Geology, and Technology).	Exploratory and quantitative.	Necessary to address issues of sustainability including waste in order to prepare teachers that are competent and willing to teach such important topics.
Tuğba Abanoz & Defne Yabaş (2025)	Effect of a STEM program on increasing children's awareness of sustainability issues. Using pre- and post-interviews, the purpose of the study was to examine the change in children's understanding of the content and skills associated with waste, reduce, reuse, and recycle concepts within the Zero Waste Hierarchy.	This research focused on a group of 10 preschool children, all 5 years old, with an equal gender distribution (5 girls and 5 boys)	A case study approach to explore our research questions. Case study research is invaluable for its ability to explore complex phenomena within their real-life contexts	A notable improvement in children's understanding of recycling. However, there was a gap in children's understanding of the concepts of 'reduce' and 'reuse'.
Solveig T. Børresen et al. (2022)	Local appreciation of ecosystem services and knowledge of how the foundation of these services is affected by local livelihoods are important for the sustainability of natural resources and thus may fundamentally affect human well-being.	Data to evaluate the impact of the educational programme were collected using a questionnaire survey given to 30 students at second level from each of the six boarding schools (aged 14–20 years).	A Survey research	The increased awareness of ecosystem services gained via the education programme suggests that education programmes can be an important tool in conservation biology. Therefore, we recommend that education programming dealing with threats to ecosystem services and biodiversity should be included in school

Authors and Year	Research Questions or Focus	Sample	Methods	Key Findings Related to Sustainability Awareness
				curricula, especially for students close to protected areas.
Jericho E. Padilla1,2 et al. (2024)	This study examines senior high school students' awareness and integration of the Sustainable Development Goals (SDGs) within a Philippine STEM school context.	A total of 131 senior high school students participated: 60 Grade 11 students and 71 Grade 12 students.	The study employed a quantitative descriptive design through a survey questionnaire adapted from the study of Yuan et al.	These outcomes advocate for the adoption of innovative, cross-curricular pedagogical strategies, and enhanced career guidance programs to more effectively align sustainability education with national strategic frameworks and prepare students for sustainability-driven professional pathways.
Enie Novieastari et al (2022)	The Sustainable Development Goals (SDGs) are a universal action toensure peace and prosperity by 2030 by rising to meet various challenges.	A total of 138 students from three discipline clusters participated	This study was a cross-sectional survey.	Applicable individualand population-level methods of informing people about the SDGs become crucial, and they should be put in place in all sectors, including educational settings.
Claire Tusoy (2024)	The integration of the SDG in the teacher education curriculum could contribute to the intensification of the SDG which is called for among higher education institutions.	A sample population of 238 second, third, and fourth-year students enrolled in the Bachelor of Elementary Education program at Mindanao State University-General Santos City Campus	This study used a quantitative approach complemented by a qualitative approach. Using a correlational design	Respondents' awareness of sustainability is varied, however, uniform in the sense that they have the notion and perspectives of the said subject matter.
Heather et al. (2016)	Evaluate the feasibility of conducting a randomized trial among 4-yearold children to evaluate the efficacy of a preschool/kindergarten curriculum interventions on children's knowledge about healthy eating, active play and the sustainability	Intervention was delivered, with the consent of the educators, to six kindergarten groups across the two regions; the wait list control also comprised six kindergarten groups.	Qualitative design an Quantitative design	Intervention is feasible to deliver and most importantly secured the engagement of the educators and the management staff of ECMS. Child participation in the curriculum interventions appeared positive, further attesting to the feasibility of conducting this randomized trial.

Authors and Year	Research Questions or Focus	Sample	Methods	Key Findings Related to Sustainability Awareness
	consequences of their food and toy selections.			
Frederica Mojilis (2019)	Timely to examine University College Sabah Foundation (UCSF) students' sustainability awareness to find out if the green campus concept has made them more aware of their surroundings.	Quantitative research using questionnaire survey is used to measure the level of sustainability awareness of the students and to examine	A total of 276 students (169 diploma and 107 degree), out of about 600 students participated in the survey.	Sustainability knowledge and sustainability information have a significant influence in determining the level of sustainability awareness of the students.

In table 2 some of these studies highlight the critical need to strengthen sustainability education, especially among secondary school students, where gaps in educational knowledge and practice present opportunities for improvement. A balanced approach in science education is essential - one that combines technical knowledge with critical engagement in sustainability issues to foster deeper awareness among future educators. The study revealed that although students showed an increased understanding of recycling, their understanding of broader concepts such as "reducing" and "reusing" was still limited, indicating that curriculum enhancements in learning for sustainability awareness need to be considered. Educational programs have proven effective in raising awareness of the benefits of maintaining ecosystems and biodiversity, suggesting integration into the school curriculum, especially for students near protected areas. Innovative and cross-curricular teaching methods and career guidance aligned with sustainability frameworks are recommended to better prepare students for sustainability-focused careers. In addition, raising awareness of the Sustainable Development Goals (SDGs) through customized educational interventions is essential across all sectors.

Table 3. Summary of Research Analysis Results with undergraduate as participants on Sustainability Awareness

Authors and Year	Research Questions or Focus	Sample	Methods	Key Findings Related to Sustainability Awareness
Kelvin (2022)	Understanding both the human dimension (community awareness and	A total of 1,040 samples were collected to assess lizard abundance	This multi-method approach allowed the	These findings highlight that while sustainability awareness is high among university students and local

Authors and Year	Research Questions or Focus	Sample	Methods	Key Findings Related to Sustainability Awareness
	participation) and the ecological outcomes of afforestation in a semi-arid Tanzanian context	and diversity. The awareness component involved 394 undergraduate students.	study to robustly assess both social (awareness, participation) and ecological (lizard diversity) impacts of afforestation in the Dodoma region.	communities in Dodoma, targeted education and stakeholder engagement are essential to bridge knowledge gaps and ensure the lasting success of afforestation and conservation efforts
Aldrex A (2025)	a study on the environmental sensitivity and Earth Science performance perceptions of first-year teacher education students, highlighting the need for improved teacher education programs to foster sustainable practices	The study involved a total of first-year teacher education students, who were selected through a combination of stratified random sampling and complete enumeration.	The study uses a descriptive correlational design within a mixed-methods framework	The study identifies the most and least observed sound and unsound environmental practices among students, revealing critical areas for improvement
Sara Bromesson (2025)	This study investigates the didactical choices made by Science Studies teachers in Swedish upper-secondary schools regarding sustainable development (SD) education	A total of 155 Science Studies teachers participated, representing approximately 10% of all teachers in this subject area	The study utilized a questionnaire to gather data on teachers' didactical choices in SD education, informed by focus group discussions	Teachers aim for students to understand that sustainability is a collective responsibility, but practical engagement in sustainability issues is less emphasized.
Mathilde Vandaele (2022)	explores the role of hope in fostering proactive sustainability engagement among university students, emphasizing the need for educational strategies that	A total of 20 candidates were contacted for interviews, with 13 agreeing to participate	This qualitative study employs interviews with university students enrolled in sustainability programs to gather insights	The iterative relationship between hope and proactive engagement, emphasizing the need for educational practices that acknowledge and integrate emotional dimensions into sustainability education

Authors and Year	Research Questions or Focus	Sample	Methods	Key Findings Related to Sustainability Awareness
	promote constructive hope in the face of climate change		on hope and engagement.	
Khue Dinh PHAM (2025)	Analyzes the role of human beliefs and trust in sustainable development amidst the challenges and opportunities presented by globalization, emphasizing the importance of education, cooperation, and technology in fostering a resilient society	This study uses qualitative methods to analyze, compare, and clarify the difference between faith in products and faith in fellow human beings	it focuses on analyzing themes and conceptualizing relationships rather than reporting survey or experimental data that involves a measurable sample.	A balance between individual freedom and social responsibility is crucial for sustainable development and Technological innovation must align with sustainable social values to maximize benefits
Eko Handoyo et al (2024)	Increasing awareness and positive attitudes toward environmental conservation among prospective teacher students is essential to ensure that future generations understand the importance of sustainability and apply it in their daily lives and educational practices.	The number of participants in this study was approximately 156 to ensure the representativeness and reliability of the results.	This study uses a quantitative approach with a survey method involving prospective teacher students from Teacher Professional Education at the State University of Semarang Indonesia.	This study provides insight into the dimensions of attitudes that shape the views of prospective teacher students toward environmental conservation and supports the use of this instrument in educational research and conservation policy.
Zeynep Ozyurt et al. (2025)	This study investigates the levels of biodiversity awareness and conservation behaviours among science teacher candidates and examines the extent to	216 teachers candidates enrolled in the Science Education program within the Department of Mathematics and Science Education	A survey-based research design	Teacher candidates should be encouraged to participate in sustainability initiatives, field-based environmental studies, and community-led conservation efforts. By fostering a deeper connection with nature and embedding

Authors and Year	Research Questions or Focus	Sample	Methods	Key Findings Related to Sustainability Awareness
	which these levels vary across demographic and academic variables	at the Faculty of Education		biodiversity conservation into educational practice.
David M. Blodgett (2020)	The sustainability of the global food system hinges on its environmental resiliency and safety,including the health and well-being of its labor force.	The authors designed a co-taught module in which they joined each other's respective history and science class sessions at the undergraduate business college where they teach	Comparisons between pre- and post-module survey responses, alongside assessments of a coauthored exam question, measured the effectiveness of this module is changing students' perspectives as food consumers and as citizens.	The module described here builds on previous demonstrations of the value, significance and effectiveness of cross-disciplinary collaborations; it pioneers the use of the food system as the link between social and environmental sustainability education.
Ahmad Basheer et al. (2025)	Evaluate the awareness of pre-service science teachers regarding green chemistry, sustainability, and their perspectives on environmental education.	A total of 198 pre-service science teachers from primary and secondary school programs at a teacher education college	The pre- and post-survey comparison showed a significant increase in sustainability awareness	This innovative approach to integrating sustainability into science education underscores the importance of preparing future educators to address environmental challenges in their teaching
Petra Bezeljak et al. (2020)	Sustainable development (SD) is one of the global and central aims of today's politics.	60 Slovenian and 60 Austrian pre-service biology teachers participated in the questionnaire-based study	Questionnaire-based study. Pre-service biology teachers answered a set of Likert-type and open survey questions.	Research contribute to the evaluation and development of curriculum for middle and high school biology teachers.
Jati, H. F., et al (2019).	The Sustainable Development Goals (SDGs) are built on the successes of the	The questionnaire was sent by mail to 450 students in the Faculty of	The data was collected by an online questionnaire,	Both awareness and knowledge are not affected by students' participation in the organization

Authors and Year	Research Questions or Focus	Sample	Methods	Key Findings Related to Sustainability Awareness
	Millennium Development Goals (MDGs), which consists of 17 goals as a universal call to action to end poverty, protect the planet, and ensure that all people enjoy peace and prosperity.	Economics, Universitas Muhammadiyah Yogyakarta	consisting of three major parts in addition to the basic information of the surveyed university students	
Ayse Ceren A et al (2019)	Raising the sustainable development awareness is of great importance for the continuation of the world's livability. Teachers have a great responsibility in order for individuals to make sustainable development a part of their lives.	425 science teacher candidates from seven state universities in Turkey participated in the research.	In this study, the validity and reliability analyses of the sustainable development awareness scale developed for science teacher candidates were conducted	In light of the analyses, the scale was found to possess the qualifications to determine the sustainable development awareness of science teacher candidates.

In Table 3, some of these studies revealed that although students and communities have high sustainability awareness, targeted education and stakeholder engagement are still crucial to address knowledge gaps and ensure the long-term success of greening and conservation initiatives. The study identified good and bad environmental practices among student teachers, and pointed out key areas for improvement. While teachers emphasized that sustainability is a shared responsibility, practical engagement in sustainability issues is often under-emphasized in educational settings. A balance between individual freedom and social responsibility is essential for sustainable development, and technological innovation must be aligned with sustainable social values to maximize its impact. Future teachers' attitudes towards environmental conservation are shaped by multiple dimensions, highlighting the need for active participation in sustainability initiatives, field-based environmental studies and community-led conservation efforts. Strengthening their connection with nature and embedding biodiversity conservation into teacher training programs can enhance sustainability education.

A systematic literature review (SLR) is an approach used to identify, evaluate, and synthesize relevant research findings in a particular field. Here, an SLR examines studies

discussing the relationship between learning models and sustainability or sustainability awareness. These studies employ different research methods and sample sizes and provide deep insights into the effectiveness of specific learning strategies in promoting sustainability awareness. Some Scopus journals are subscription-based, so not all 39 articles could be analyzed, which limits this study. Table 1 below summarizes some of the analyzed studies. It can be seen that many related articles were conducted using survey methodology with a large number of participants. Awareness cannot grow with just one treatment; for sustainable awareness, continued reinforcement or habits are needed so that it can be optimized.

D. Conclusion

While sustainability awareness significantly contributes to science education, it is important to recognize the challenges and limitations in its implementation. The integration of sustainability concepts into science curricula requires ongoing research, collaboration, and innovation to ensure that students are adequately prepared to address global sustainability challenges. Additionally, the effectiveness of sustainability education can be enhanced by incorporating diverse perspectives and methodologies, such as local wisdom and digital learning tools, to make learning more relevant and engaging for students.

The systematic literature review on sustainability awareness in science education emphasizes how important it is for encouraging students' scientific engagement, environmental literacy, and responsible citizenship. According to key studies, by relating scientific ideas to actual environmental issues, incorporating sustainability into science curricula improves students' critical thinking, problem-solving abilities, and ethical decision-making. Widespread adoption is hampered by issues like inadequate teacher preparation, curricular limitations, and cultural differences. Future initiatives should concentrate on multidisciplinary approaches, teacher professional development, and student-centered pedagogies that prioritize experiential, sustainability-focused learning in order to optimize effect. Teachers can equip the next generation to effectively handle global environmental concerns by bridging the gap between science instruction and sustainability consciousness.

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