



# Bridging Science Education and SDGs: Systematic Review and Bibliometric Mapping of Sustainable Awareness Trends

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Article Info	Abstract
<p><b>Keywords:</b> ESD; PRISMA; SDGs; Sustainable Awareness; Systematic Literature Review;</p> <hr/> <p><b>Received:</b> 29/04/2026 <b>Revised:</b> 05/05/2026 <b>Accepted:</b> 13/05/2026</p>	<p><b>Background:</b> The objective of this study is to map research developments, conceptual characteristics, and existing research gaps by systematically synthesizing scientific literature on sustainable awareness within the context of education.</p> <p><b>Methods:</b> A Systematic Literature Review (SLR) guided by the PRISMA framework was employed as the primary methodological approach. Relevant articles were retrieved from the Scopus database across selected publication years and subsequently analyzed using bibliometric and thematic analysis to identify publication trends and the distribution of research in this field.</p> <p><b>Results:</b> The findings indicate that sustainable awareness is a multifaceted construct encompassing cognitive, affective, behavioral, and transformational dimensions. However, measurement indicators remain inconsistent across studies, and cross-contextual research collaboration is still limited.</p> <p><b>Conclusion:</b> The study of sustainable awareness is still dispersed and requires more robust theoretical integration as well as standardized assessment instruments. The knowledge-attitude-behavior paradigm provides a basis for a more cohesive framework. Limited international cooperation is also highlighted in the study. To raise awareness of sustainability and encourage significant behavioral change, education, technology, and community involvement must be strengthened.</p>

## INTRODUCTION

As environmental degradation, climate change, and social inequality, issues that directly affect human quality of life, continue to intensify, sustainability has emerged as an urgent global concern. In this context, achieving sustainable development requires not only policy interventions and technological innovations but also fundamental transformations in the ways individuals think, perceive, and behave. One key concept that plays a critical role in facilitating such transformation is sustainable awareness, which reflects individuals' understanding, attitudes, and behaviors toward environmental, social, and economic sustainability. Sustainable awareness is inherently multidimensional, encompassing both cognitive and affective dimensions. These include knowledge of sustainability-related issues, an understanding of the environmental consequences of human actions, and an intrinsic motivation to act responsibly. Furthermore, sustainable awareness also involves the development of values, beliefs, and sustainable practices in everyday life, such as responsible resource management, energy conservation, and active participation in environmental preservation (Ploum et al., 2018; UNESCO, 2017).

Education for Sustainable Development (ESD) plays a central role in fostering this awareness. Education is widely recognized as a crucial means of shaping a generation that is critically aware of global challenges and capable of contributing to the achievement of the Sustainable Development Goals (SDGs) (UNESCO, 2021). In particular, the integration of the SDGs into science education has gained increasing global attention, as this field is considered a key pillar in developing intergenerational sustainability literacy. This integration is especially important in supporting the achievement of Quality Education (SDG 4) and Climate Action (SDG 13) (Akçay et al., 2024; Ahovi & Edmond, 2025). Various studies have demonstrated that learning approaches integrating sustainability-related issues can enhance students' ecological responsibility and increase their readiness to adopt sustainable behaviors (Lozano et al., 2019).

Recent trends in scientific publications indicate a significant increase in studies emphasizing the role of science education in integrating the Sustainable Development Goals (SDGs). Major research themes include curriculum innovation, project-based learning, service learning, and interdisciplinary approaches that link scientific concepts with real-world sustainability challenges (Baraka & Moustafa, 2023; Didham & Robert, 2024). Furthermore, contextual learning approaches, such as the integration of local wisdom and Ethno-STEM, have been shown to enhance the relevance of science education, increase student engagement, and promote deeper awareness and more positive attitudes toward sustainability (Pada et al., 2025; Sihombing et al., 2025).

However, the current research landscape continues to face substantial challenges. From a practical perspective, numerous studies have identified persistent structural barriers, including limitations in teacher readiness, curriculum fragmentation, and low levels of SDG literacy among learners. These challenges vary across educational disciplines and geographical contexts (Zamora-Polo et al., 2019; Reverte & Carmelo, 2022). From a theoretical standpoint, research findings often appear fragmented due to the use of diverse conceptual perspectives, such as environmental literacy, sustainability competencies, or ecological citizenship, which lead to variations in operational definitions and measurement approaches (Brundiers et al., 2021). Furthermore, much of the existing research remains concentrated within specific geographical contexts, thereby limiting a comprehensive understanding of global patterns and trends. Given this complexity, a Systematic Literature Review (SLR) combined with bibliometric mapping is required to comprehensively synthesize the existing empirical evidence. The purpose of this study is to examine research developments, identify the dimensions and indicators of sustainable awareness employed in previous studies, and uncover existing research gaps. This study differs from previous

reviews by examining sustainable awareness from a multidimensional perspective, integrating it with the Education for Sustainable Development (ESD) and Sustainable Development Goals (SDGs) frameworks, and providing a methodological synthesis of prior research.

This study employs the PRISMA protocol and VOS viewer-assisted bibliometric analysis using data retrieved from the Scopus database up to December 31, 2025, to address three main research questions: [RQ1] *Does the exploration of sustainable awareness remain a relevant and significant topic for future scientific inquiry?*; [RQ2] *What are the current distribution patterns and publication trends of research on sustainable awareness in the academic literature?*; and [RQ3] *What theoretical contributions and practical implications emerge from existing studies on sustainable awareness, and how can these findings inform future research? The findings of this study are expected to provide a strong conceptual foundation and practical recommendations for strengthening the role of science education in supporting the achievement of the Sustainable Development Goals (SDGs) and enhancing global sustainability awareness.*

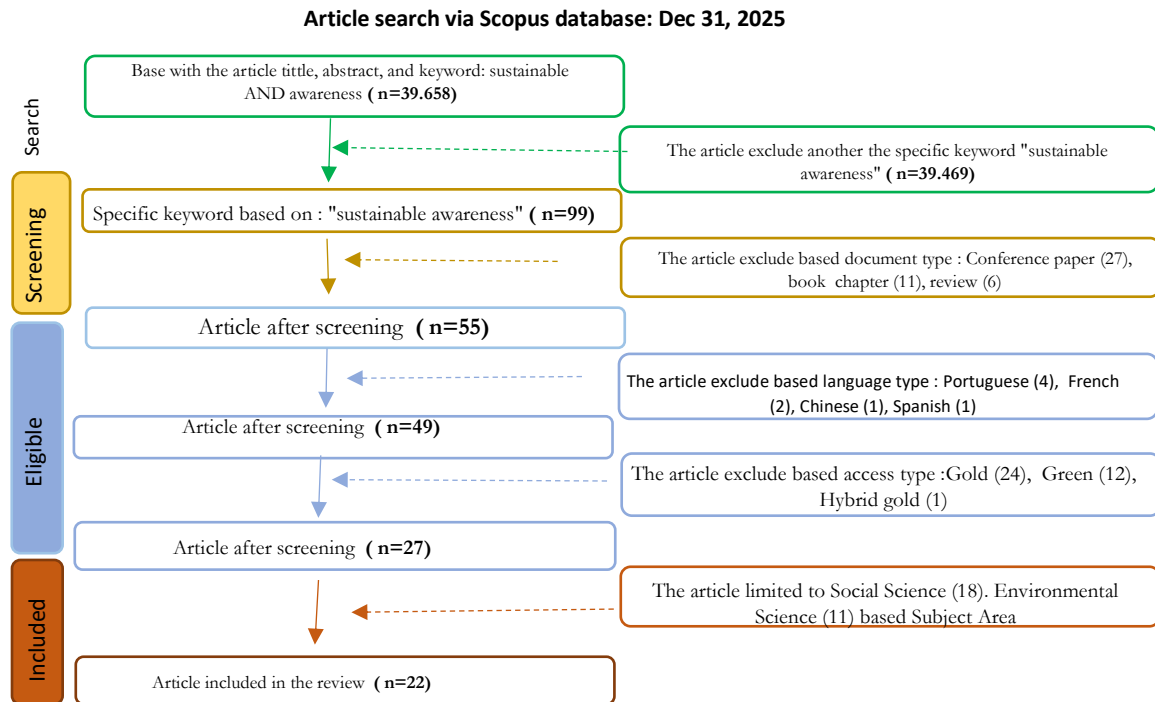
## METHODS

A systematic literature review using a bibliometric approach conducts a quantitative evaluation of the literature to identify patterns, trends, and key research entities within a specific field of study. This approach, which employs frameworks such as PRISMA, ensures that the review process is systematic and replicable while providing a clear and transparent overview of the subject under investigation (Sucilestari et al., 2025). This review follows three main inclusion criteria: (1) articles must be published by December 31, 2025; (2) articles must be written in English; and (3) articles must focus on sustainable awareness. Bibliometric analysis is conducted using VOS viewer software, which visualizes bibliographic data such as citation networks, author collaborations, and keyword co-occurrence. These visualizations help reveal the intellectual structure and research dynamics within the field.

Researchers can map the landscape of research activity and synthesize empirical findings by integrating bibliometric analysis with systematic reviews. This approach enables the identification of key contributors and emerging research trends within a specific field. The combination of these methods provides valuable insights for multidisciplinary studies while offering a comprehensive understanding of the field's development, historical evolution, and future prospects. In scientific publishing, bibliometric analysis is often strategically employed to examine patterns of knowledge production and dissemination. The first step in this research process involves keyword selection, which can be conducted using a macro (top-down) approach. This approach begins with a broad search strategy before narrowing the focus to specific studies and thematic areas. Based on an assessment of gaps in previous research and the limited number of studies explicitly addressing sustainable awareness, this study focuses on the keyword "sustainable awareness" in article titles, abstracts, and keywords. The Scopus database was selected as the primary data source due to its extensive coverage of peer-reviewed international publications and its widespread use for literature reviews, identifying subject-matter experts, and monitoring global research trends.

Figure 1 illustrates the article selection process for the systematic literature review and bibliometric analysis on sustainable awareness. Based on a literature search conducted on December 31, 2025, through the Scopus database, a total of 39,658 documents were initially retrieved using the keywords "sustainable AND awareness" in article titles, abstracts, and keywords. During the initial screening phase, 39,658 articles were excluded because they did not contain the specific phrase "sustainable awareness," leaving 99 articles for further evaluation. Subsequently, the articles were categorized by document type, including conference proceedings

(27), book chapters (11), and review articles (6), resulting in 55 potentially eligible articles. In the next screening stage, articles were excluded based on language, specifically those published in Portuguese (4), French (2), Chinese (1), and Spanish (1), reducing the number of articles to 49. Further refinement was conducted by excluding articles based on access type, including Gold (24), Green (12), and Hybrid Gold (1). This process resulted in a final set of 27 articles considered eligible for inclusion. In the final stage, articles were screened based on subject area, retaining only those categorized under Social Sciences (18 articles) and Environmental Sciences (11 articles). Ultimately, 22 articles were included in the final systematic literature review.



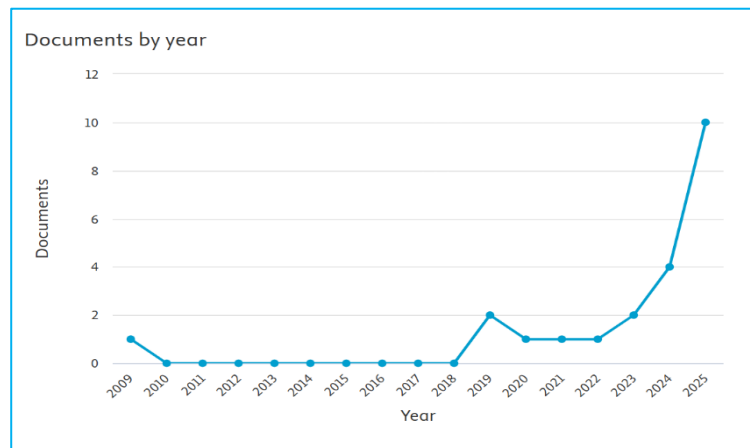
**Figure 1.** Information flow of the systematic literature review using PRISMA

## RESULT AND DISCUSSION

The focus of this research is the findings derived from 22 articles retrieved from the Scopus database concerning sustainable awareness. The data were analyzed by identifying the number of articles published, publication trends over the years, and the journals in which the articles appeared.

*RQ1: Does the exploration of Sustainable Awareness remain a relevant and significant subject for scientific inquiry in the future?*

Figure 2 illustrates the publication trends related to the research topic. The analysis shows that publications on sustainable awareness were very limited and sporadic during the period 2009–2018, and were even absent in several years. This condition indicates that the research topic had not yet developed significantly and had not become a major focus of scientific inquiry during that period. Publications began to reappear in 2019, although the number remained relatively low. Between 2020 and 2023, publications gradually increased but remained limited in number.

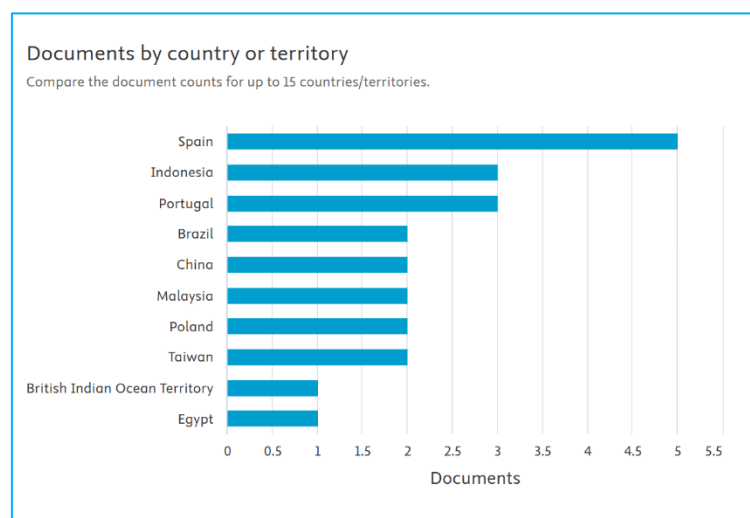


**Figure 2.** Distribution of articles by year. Source: Scopus Database

A more substantial increase is observed in 2024, with four publications, and in 2025, with ten publications. Based on this pattern, this Systematic Literature Review (SLR) focuses on the period 2019–2025. This time frame was selected because earlier publications were very limited, whereas recent studies provide more relevant insights aligned with current conceptual and methodological developments in sustainable awareness research.

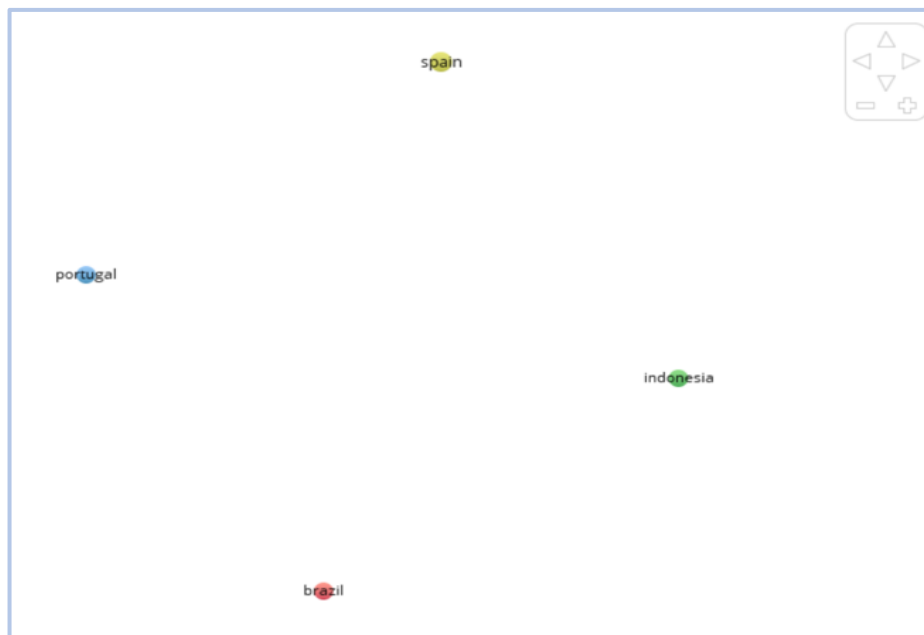
*RQ2: What is the current distribution and trend of publications on Sustainable Awareness in academic literature?*

Figure 3 presents the geographical distribution of research on sustainable awareness across different countries and regions. At the identification stage of the Systematic Literature Review (SLR) process, the distribution of publications was analyzed based on the country or region of the authors' institutional affiliations. The results indicate that contributions to this research topic are uneven and originate from a variety of countries. Spain contributed the highest number of publications with five documents, followed by Indonesia and Portugal, each contributing three documents. Brazil, China, Malaysia, Poland, and Taiwan each contributed two documents, while the British Indian Ocean Territory and Egypt each contributed one document. Although contributions from Africa and several other regions remain limited, this distribution demonstrates that research on sustainable awareness has expanded internationally, particularly in Europe, Asia, and Latin America.



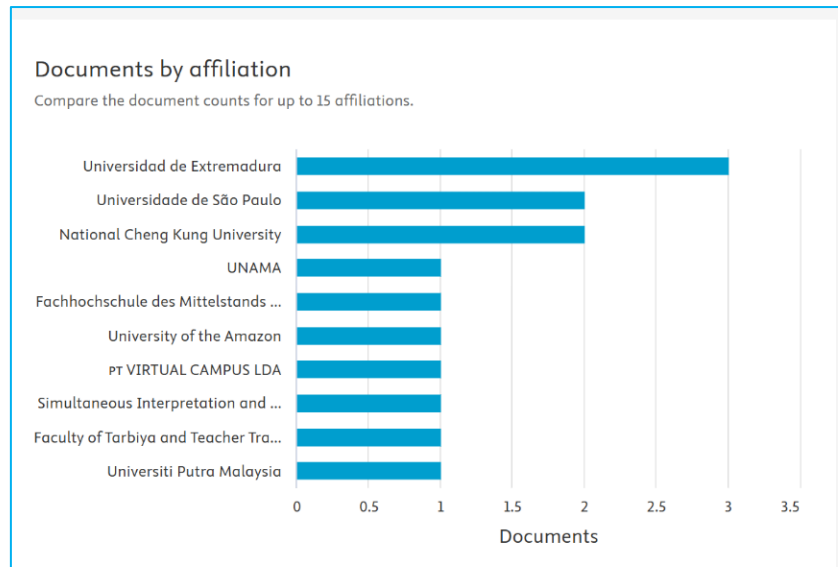
**Figure 3.** Distribution of articles by country. Source: Scopus Database.

Figure 4 illustrates the relationships between the countries involved in sustainable awareness research. According to the results of the network visualization, four countries, namely Spain, Portugal, Indonesia, and Brazil, contributed to the dataset. Each country is represented by a single node, forming four separate clusters. The VOSviewer visualization reveals a fragmented collaboration structure, where countries such as Spain, Indonesia, Portugal, and Brazil appear as isolated nodes without linkage. Low network density and inadequate knowledge integration are shown by the lack of co-authorship relationships. As a result, research on sustainable consciousness is still isolated in national contexts. This disparity highlights the necessity of more robust interdisciplinary and cross-national cooperation to strengthen theoretical integration and future research's worldwide applicability and generalizability. Furthermore, the limited and relatively equal number of nodes suggests that the contribution of publications from each country remains relatively small, with no single country demonstrating clear dominance in the research landscape.



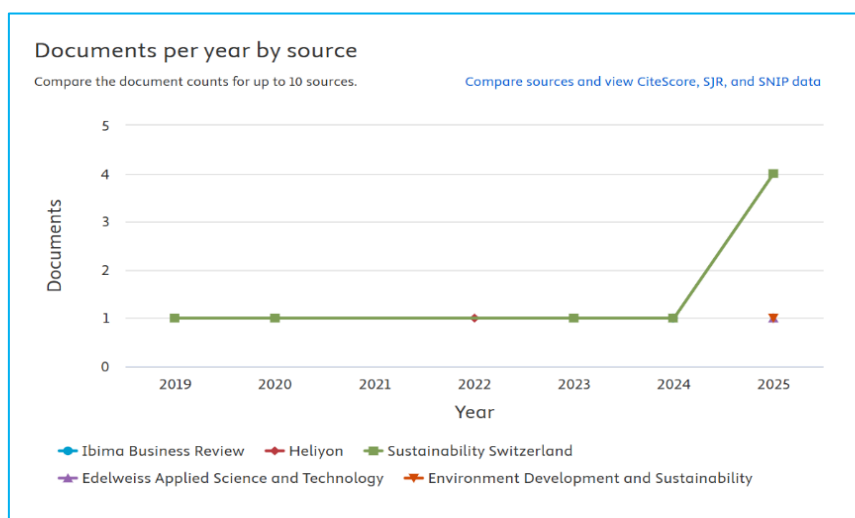
**Figure 4.** Network visualization of countries. Source : VOSviewer

Figure 5 highlights the bibliometric analysis to identify the distribution of research publications on sustainable awareness based on institutional affiliation. The analysis results show that the University of Extremadura has the highest number of publications, with 3 documents. The University of São Paulo and National Cheng Kung University each sent 2 documents, indicating that both universities were relatively consistent in their involvement in the development of the research topics discussed. Some other institutions, such as UNAMA, Fachhochschule des Mittelstands FHM, University of the Amazon, PT Virtual Campus LDA, and Universiti Putra Malaysia, only provide one document. The absence of a dominant institution indicates that this field of study is still developing and institutionally fragmented; this contribution shows that research contributions are still dispersed and not yet centered on a single institution. This result allows for cross-institutional collaboration to improve the consistency and depth of future research.



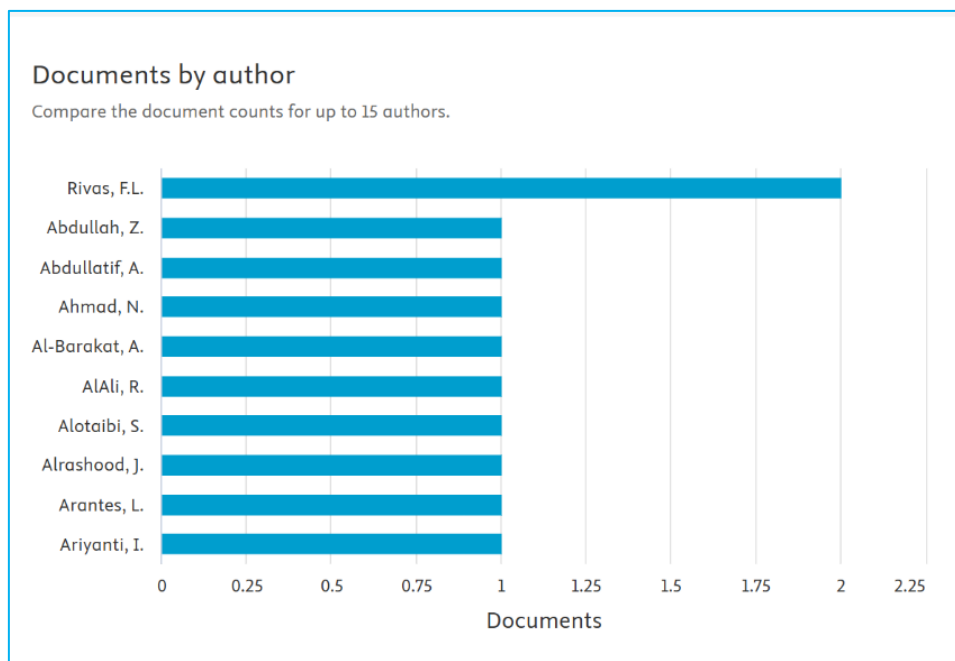
**Figure 5.** Distribution of articles by affiliation. Source: Scopus Database.

Figure 6 illustrates the distribution of studies on sustainable awareness based on publication source. Based on 22 documents evaluated from 2019 to 2025, the graph of Documents per year by source shows an uneven contribution pattern among journals. The analysis results show that the journal Sustainability (Switzerland) has 8 documents as the most frequent source of publication. From 2019 to 2024, the publication of this journal has been relatively stable, and it increased significantly in 2025. This increase indicates greater academic attention to the research topic discussed. Other journals, such as Heliyon, Ibima Business Review, Edelweiss Applied Science and Technology, and Environment, Development, and Sustainability, only submitted one article during the observation period. These findings indicate that the research topic is still in the strengthening and consolidation phase, while also showing that scientific discourse in this field of study is still concentrated and has not spread widely, as publications in one major journal and contributions from other journals are limited. Additionally, these findings open opportunities for expanding publication in subsequent research across various quality journals.



**Figure 6.** Number of Articles by Source (Top 10 Sources). Source: Scopus Database.

Figure 7 illustrates the distribution of articles by author. Based on the 22 documents analyzed, the Documents by author graph shows a relatively even contribution pattern without the dominance of any particular author. The analysis results show that Rivas Lozano (2023) is the author with the most publications, with 2 documents. Meanwhile, most other authors, such as Abdullah Zulhamri (2024), Abdulatif Ali (2025), Ahmad, Nadiah (2025), Al Barakat, Al Ali Romel, Alotaibi, Alrashood (2025), Arantes Luzia (2025), and Ariyanti Ika (2025), each contributed only one document. According to this contribution, research in this field is still individual and widespread. Additionally, there is no stable core author group yet. The absence of author dominance indicates that the research topic is still in its early stages of development. This condition provides an opportunity for future research to develop more collaborative networks, increase publication continuity, and deepen theories and methodologies related to the research field discussed.

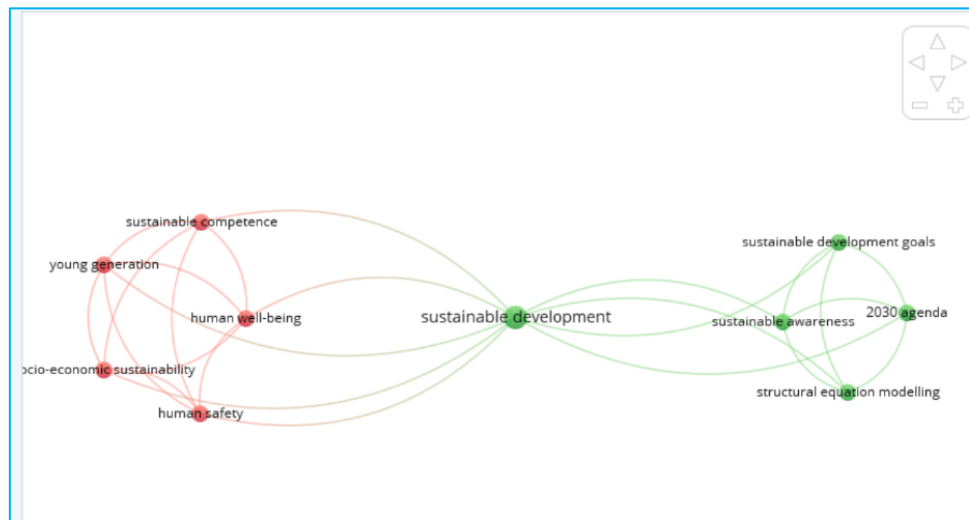


**Figure 7.** Number of Articles by Author (Top 10 Sources). Source: Scopus Database.

**RQ3:** *What are the theoretical contributions and practical implications derived from existing studies on sustainable awareness, and how can these findings guide future research?*

Bibliometric analysis using VOSviewer can identify which variables have been extensively examined by previous scholars and which remain underexplored, thereby providing a foundation for future research. Based on Figure 8 and Table 1, research related to sustainable awareness reveals a co-occurrence network of keywords. The network visualization identified ten keywords forming two main clusters, with a total of 25 relationships among the keywords. The first cluster focuses on the social and human dimensions of sustainability, including keywords such as *human well-being*, *human security*, *youth*, *socio-economic sustainability*, and *sustainable skills*. The strong connections among these keywords indicate that existing studies emphasize the role of human well-being, security, and youth skills development in supporting socio-economic sustainability. The second cluster highlights the policy dimensions and global frameworks of sustainability, with key keywords including *sustainable development*, *sustainability awareness*, *sustainable development goals*, *the 2030 Agenda*, and *structural equation modeling*. Within this network, the keyword

*sustainability* serves as a central node linking the two clusters, indicating its role as a key concept in academic discussions on sustainable awareness.



**Figure 8.** Keywords by Author

**Table 1.** Keywords by Author

Rank	Keyword	Occurrences	Total Link Strength
1	sustainability consciousness	1	5
2	sustainability competence	1	5
3	young generation	1	5
4	2030 agenda	1	4
5	environmental awareness	1	4
6	environmental education	1	4
7	Environmentally	1	4
8	Evaluation	1	4
9	primary science education	1	4
10	quality 4.0	1	4

Currently, sustainable awareness has become an urgent need and must be incorporated into various fields of life, from basic education to heavy industry. Education as an Initial Foundation: Nursifah, Sari, and Supadi (2025) emphasize that schools play an important role in shaping students who are sensitive to their environment. This awareness encompasses both emotional and cognitive aspects. Hernández-Barco and colleagues (2022) argue that science education should be able to connect emotional abilities and environmental knowledge. So that they can pass on sustainable awareness to future generations. Cruz (2021) suggests a Content and Language Integrated Learning (CLIL) approach at the primary education level to enhance "creative-practical skills" that support global sustainability awareness from a young age. Rahmat et al. (2025) found that environmental literacy is key to encouraging communities to protect their ecosystems for a better future. Contemporary technology also acts as an accelerator. Novo et al. (2024) emphasize that technology helps society adopt environmentally friendly habits more consistently. Tadesse (2024) reminds us that significant problems often arise at the implementation level.

**Table 2.** summarizes the key elements of Sustainable Awareness, which involves a systematic and iterative process that spans various fields.

Define of Factor Sustainable Awareness	References
Sustainable awareness is defined as the understanding of how daily behaviors and activities impact the environment, fostering critical thinking about actions and their effects, and motivating individuals to seek practical solutions for environmental issues affecting everyone	Ali Barakat, et al (2025)
Sustainable awareness is defined as individuals' understanding and concern for environmental issues, encompassing their attitudes and behaviors aimed at protecting and maintaining natural balance while promoting sustainable development. This concept reflects the level of knowledge, emotions, and actions individuals take towards environmental challenges, particularly in the context of students' responsibilities in safeguarding the planet and fostering a sustainable future.	Nam Nguyen-Dinh, et al (2025)
Sustainable awareness is defined as the harmonization of environmental literacy, community readiness, and education, enabling individuals to make informed decisions regarding ecological sustainability and resource conservation.	Hayatul Khairul Rahmat, et al (2025)
Sustainable awareness is defined as the understanding and recognition of sustainability challenges, which is fundamental for fostering behavioral changes aligned with sustainable development principles. It encompasses knowledge, attitudes, and behaviors that influence effective sustainable practices, such as recycling and energy conservation.	Luzia Arantes et al (2025)
Sustainable awareness is defined as the understanding and recognition of the importance of sustainable practices and their impact on individual and collective prosperity. The paper argues that raising sustainable awareness can accelerate contributions to the implementation of the Sustainable Development Goals (SDGs) as represented in Shakespeare's work, which critiques unsustainable practices and advocates for sustainability.	Ahmed Shehata Sayed Semida., et al (2024)
Sustainable awareness refers to the understanding of how individual actions collectively impact the environment, fostering a sense of responsibility towards ecological issues. It encompasses knowledge about sustainability and the effects of one's actions, which can motivate individuals to take action.	Carolina Novo et al (2024)
Sustainable awareness refers to the understanding and recognition of the importance of sustainability in various contexts, particularly in education. It involves promoting values such as respect for human rights, environmental awareness, and participation in democratic processes, which are essential for integral development and addressing global challenges.	Miriam Andrea Hernández-Barco et al (2022)
Sustainable awareness is defined as a global understanding that promotes values and behaviors aimed at ensuring a sustainable future for the planet and society. It encompasses critical thinking and creativity, which are essential for addressing global issues and fostering a positive transformation towards equality and respect for diversity.	Mário Cruz et al (2021)
Sustainable awareness is characterized by the understanding of the interconnectedness between social and ecological realities, emphasizing the need for a critical eco-citizenship that incorporates economic, environmental, and social dimensions to achieve quality environmental education.	Francisco Del Cerro Velázquez et al (2020)

Sustainable awareness is defined as the level of understanding and recognition of sustainability concepts within a company, assessed through a questionnaire targeting various respondents, including production experts. This awareness encompasses sustainability drivers, barriers, and benefits associated with its implementation in the production process.	Rina Fitriana et al (2025)
Sustainable awareness refers to the understanding and recognition of the interconnectedness between individuals, the environment, and society, which is essential for promoting sustainable development in education	Lorena Gutiérrez-García, et all (2024)
Sustainable awareness refers to the understanding and integration of environmental practices into daily life, as seen among açai berry extractive farmers who have incorporated practices such as recycling and reducing pollution prior to certification.	Mariana da Silva Cavalcanta et al (2025)

Based on the previous researchers' definitions, sustainable awareness is a holistic understanding that encompasses individuals' knowledge, values, attitudes, and actions in comprehending the interconnectedness of environmental, social, and economic factors, as well as the impact of human activities on sustainability. This awareness develops thru understanding sustainability issues and the SDGs, fostering a sense of responsibility and environmental care, and is manifested in concrete behaviors such as sustainable decision-making and environmentally friendly practices. Implementing sustainable awareness in education plays an important role in driving behavioral change, shaping sustainable mindsets, and strengthening students' individual and collective contributions to sustainable development, as illustrated below.



Figure 7. Elements of Sustainable Awareness

Figure 8 shows that Sustainable Awareness is a cyclical process that combines knowledge, attitudes, and behaviors to understand and respond to sustainability issues. Strong understanding fosters environmental responsibility and concrete actions that support social and environmental transformation. This study aims to map the research landscape of Sustainable Awareness in the context of science education and SDG integration through a hybrid bibliometric approach and systematic literature review. The findings from 22 selected documents provide deep insights into the temporal dynamics, geographical distribution, and conceptual structure of this evolving field of study. The following discussion synthesizes these findings to answer the research questions posed.

Bibliometric findings reveal an exponential growth pattern in publications related to Sustainable Awareness, with a significant surge specifically in the 2024–2025 period. This phenomenon indicates that this topic has transitioned from the "incubation" phase to the "acceleration" phase. This surge strongly correlates with the increasingly pressing deadline for the 2030 Agenda. The global academic focus has shifted from simply formulating policies to practical implementation involving human behavior transformation. This confirms that Sustainable Awareness is now recognized as a key competence that young generations must possess to address the planetary crisis, where this awareness is an absolute prerequisite before sustainable action can be realized.

Despite an increase in publication volume, analysis of country and institutional distribution reveals significant fragmentation. The dominance of countries like Spain, Indonesia, and Portugal highlights the relevance of this issue in nations facing real environmental challenges or currently reforming their curricula. However, the most critical finding from the network visualization is the absence of cross-country collaboration links (zero linkage). The absence of international collaboration indicates that research on Sustainable Awareness is still "siloed" or isolated within a local context. The absence of this collaborative network limits knowledge exchange and hinders the formation of a universal global framework, indicating that the research community in this field is still fluid and not yet consolidated.

Beyond bibliometric metrics, this study qualitatively synthesizes key elements of Sustainable Awareness based on recent literature (Table 2). Unlike the traditional view that often equates awareness with simply "knowing," this finding defines Sustainable Awareness as a holistic construct that integrates knowledge, values, attitudes, and actions. As summarized in Figure 8, Sustainable Awareness is a cyclical, not linear, process. This process begins with cognitive understanding of sustainability issues and SDGs, which then triggers an affective response (care and responsibility), and ultimately manifests in real-world behavior (sustainable decision-making).

**Cognitive and Affective Dimensions:** Nursifah et al. (2025) emphasize that schools are the initial foundation for forming this awareness. However, science education should not stop at the transfer of facts. Hernández-Barco et al. (2022) argue that education should connect environmental knowledge with emotional capabilities. Without an emotional connection, knowledge will not be strong enough to drive long-term behavioral change. **Literacy as the Key:** Rahmat et al. (2025) found that the harmonization between environmental literacy and community readiness is key to maintaining ecosystems. This definition is reinforced by Nguyen-Dinh et al. (2025) and Arantes et al. (2025), who highlight that awareness must include understanding how daily activities impact the natural balance. **Pedagogical Implementation:** To achieve this from an early age, Cruz (2021) suggests innovative approaches such as Content and Language Integrated Learning (CLIL) at the elementary level to develop creative-practical skills. This aligns with the findings of Al-Barakat et al. (2025), who emphasized the importance of critical thinking in evaluating the impact of everyday actions.

The Role of Technology and Implementation Challenges: In the digital age, technology plays a dual role. Novo et al. (2024) identify contemporary technologies as accelerators that help society adopt environmentally friendly habits more consistently (e.g., thru carbon footprint monitoring tools). However, Tadesse (2024) warns of an "implementation gap." Significant problems often arise when theoretical awareness is not supported by infrastructure or a culture that enables sustainable practices in the field. Implications for the Future: The synthesis of definitions from various contexts—ranging from education (Gutiérrez-García et al., 2024) and industry (Fitriana et al., 2025) to agriculture (Cavalcanta et al., 2025)—demonstrates the universality of this concept. Sustainable awareness is a vital bridge connecting individuals' understanding of socio-ecological reality with ecological citizenship action (Del Cerro Velázquez et al., 2020). Therefore, future research should focus on how to strengthen this "Knowledge-Attitude-Behavior" cycle thru measurable educational interventions and appropriate technological support.

## CONCLUSION

This study successfully mapped research developments, conceptual characteristics, and gaps in sustainable awareness in education through systematic literature review and bibliometric analysis of 22 articles (2019–2025). Although research shows growing trends, the overall volume remains limited and fragmented across regions and institutions. Sustainable awareness is predominantly framed as a multidimensional, cyclical Knowledge-Attitude-Behavior construct integrating cognitive, affective, and behavioral components. However, critical gaps persist: lack of theoretical integration with ESD frameworks, limited cross-national collaboration (zero linkage), and insufficient empirical studies with standardized measurement approaches. Future research should prioritize developing integrative frameworks, establishing international collaborative networks, and conducting empirical studies linking awareness to behavioral outcomes in educational contexts.

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