Open Access

Asian Journal of Environmental Research
E-ISSN: 3047-4930
DOI: https://doi.org/10.69930/ajer.v3i2.755
Review Article

ScienceTech. Group

Vol. 3 (2), 2026
Page: 98-108

Trends and Impacts of Socio-Scientific Issues (SSI) Research on Students' Environmental Awareness: A Systematic Literature Review

Dewiyanti Fadly, Vika Puji Cahyani *

Department of Chemistry, Faculty of Mathematics and Natural Sciences, Makassar State University, Indonesia
*Email (corresponding author): vika.puji.cahyani@unm.co.id

Abstract. *Environmental problems such as climate change, pollution, biodiversity loss, and environmental degradation have increased the importance of developing students' environmental awareness through science education. One approach widely used to address this issue is Socio-Scientific Issues (SSI)-based learning, which integrates scientific concepts with real-world social and environmental problems. This study aimed to analyze research trends, characteristics, and the impacts of SSI-based learning on students' environmental awareness through a Systematic Literature Review (SLR). Data were collected from Scopus-indexed articles published between 2016 and 2026 using the keywords "Socio-Scientific Issues" and "students' environmental awareness." Bibliometric analysis was conducted using Mendeley Desktop and VOSviewer to identify publication trends, research themes, and thematic relationships. The findings indicate a significant increase in SSI-related research over the last decade, particularly in the fields of science education, environmental education, and sustainability studies. Climate change, sustainable development, environmental protection, and scientific argumentation were identified as dominant research themes. The review also shows that SSI-based learning positively influences students' environmental awareness, critical thinking, scientific literacy, argumentation skills, and pro-environmental behavior. Furthermore, the integration of SSI with Problem-Based Learning (PBL), Education for Sustainable Development (ESD), and digital learning tools strengthens students' engagement with environmental issues. Overall, SSI is an effective pedagogical approach for promoting environmental awareness and sustainability-oriented education. Enhancing students' environmental awareness through SSI-based learning is a critical strategy for developing sustainability-literate citizens who are capable of addressing global environmental challenges such as climate change, biodiversity loss, and pollution, in line with Sustainable Development Goal (SDG) 4.7 on Education for Sustainable Development.*

Keywords: *Socio-Scientific Issues; Environmental Awareness; Systematic Literature Review; Science Education; Sustainability*

1. Introduction

Global environmental problems such as climate change, pollution, biodiversity loss, and waste accumulation have become major challenges affecting human life and ecosystem sustainability (1). These issues highlight the urgent need to develop environmental awareness among students as future generations who will face and solve these environmental challenges. Environmental awareness is important because it helps students understand environmental issues, develop responsible attitudes, and encourage pro-environmental behaviors in daily life (2). Through environmental awareness, students' can

Received: 12 May 2026 / Accepted: 29 May 2026 / Available online: 1 June 2026

become more critical, responsible, and actively involved in supporting sustainable development and environmental protection.

Environmental awareness among students is crucial in addressing global environmental problems, as it fosters a generation capable of making informed decisions and taking responsible actions towards sustainability (3). Education plays a pivotal role in cultivating this awareness, equipping students with the knowledge, skills, and attitudes necessary to tackle environmental challenges such as climate change, pollution, and biodiversity loss. By integrating environmental education into curricula, students can develop a deeper understanding of the complex relationship between human activities and natural systems, ultimately promoting sustainable development.

Science education plays an important role in building students' environmental awareness by helping them understand scientific concepts related to environmental problems and their impacts on society (4,5). Through science learning, students can develop critical thinking, problem-solving skills, and responsible decision-making toward environmental issues. One effective approach in science education is the use of Socio-Scientific Issues (SSI), which connects scientific knowledge with real-life social and environmental problems. SSI-based learning provides contextual and meaningful experiences that encourage students to analyze controversial issues, evaluate evidence, and develop awareness and responsibility toward environmental sustainability (6,7).

Research on SSI in science education has increased considerably over the last decade, especially in studies related to environmental education and sustainable development . Many previous studies have shown that SSI-based learning can enhance students' critical thinking, scientific argumentation, decision-making skills, and engagement with real-world environmental problems (8-10). SSI approaches are also considered effective in connecting scientific concepts with social and environmental contexts, making science learning more meaningful and relevant for students (11). As a result, SSI has become an important approach in promoting environmental responsibility and sustainability-oriented education.

Despite the growing number of studies, research findings concerning students' environmental awareness remain scattered and inconsistent across different educational settings and research focuses. Some studies emphasize environmental attitudes and behavioral intentions, while others focus mainly on knowledge acquisition or argumentation skills. In addition, the environmental issues used in SSI learning vary widely, including climate change, waste management, biodiversity loss, renewable energy, and pollution, which creates differences in research outcomes and perspectives. Variations in educational levels, research methods, and instructional approaches also make it difficult to obtain a comprehensive understanding of how SSI contributes to the development of students' environmental awareness.

Furthermore, most existing studies are empirical classroom-based studies conducted in specific contexts, whereas comprehensive review studies that systematically map publication trends, dominant themes, research characteristics, and the impacts of SSI on environmental awareness are still limited. Previous review studies generally discuss SSI in broad science education contexts without specifically focusing on environmental awareness as the main outcome. In particular, there is still limited systematic literature review research based exclusively on Scopus-indexed articles that provides a detailed overview of the development of this research field. Therefore, a systematic literature review is needed to

identify research trends, major findings, research gaps, and future directions regarding the role of socio-scientific issues in enhancing students' environmental awareness.

Therefore, strengthening students' environmental awareness through socio-scientific issues (SSI)-based learning is essential for fostering sustainability-literate citizens who are able to critically respond to complex environmental challenges, including climate change, biodiversity loss, and environmental pollution. This educational orientation is also aligned with the objectives of Sustainable Development Goal (SDG) 4.7, which emphasizes the importance of Education for Sustainable Development in preparing responsible global citizens.

2. Methods

2.1. Research design

This study employed a Systematic Literature Review (SLR) design to comprehensively analyze previous studies related to socio-scientific issues (SSI) and students' environmental awareness. The SLR method was selected because it allows researchers to systematically identify, evaluate, and synthesize relevant studies in a structured and transparent manner. Through this approach, the study aimed to provide a comprehensive overview of publication trends, research characteristics, environmental themes, and the impacts of SSI-based learning on students' environmental awareness. The review focused on identifying patterns and research developments within science and environmental education contexts.

2.2. Data Source

The data used in this study were obtained exclusively from the Scopus database. Scopus was chosen because it is one of the largest and most reputable international databases containing high-quality peer-reviewed journal articles across various academic disciplines. In addition, Scopus provides comprehensive indexing and citation information that supports systematic analysis of research trends and developments. The use of a single database also ensured consistency in article selection and data collection processes.

The article search process was conducted using several keywords related to socio-scientific issues and environmental awareness. The search query was applied to the title, abstract, and keyword sections of articles in the Scopus database. The search string used in this study was: "Socio-Scientific Issues" and "students' environmental awareness". The search process was conducted to identify relevant studies discussing the implementation of SSI-based learning and its relationship to students' environmental awareness. To obtain recent and relevant literature, the publication period was limited from 2016 to 2026.

The data analysis techniques in this study consisted of three stages. First, RIS data files were organized and mapped using Mendeley Desktop based on publication year, authors, and publishers. Second, bibliometric network visualization and scientific publication trends were analyzed using VOSviewer by identifying the number of clusters and related items within the research network. Third, the identified studies were further examined through a literature review process to categorize and map the main research topics discussed in the selected articles.

3. Results and Discussion

3.1. Research trends related to socio-scientific issues (SSI) and students' environmental awareness

To identify the development and characteristics of research related to socio-scientific issues (SSI) and students' environmental awareness, a bibliometric analysis was conducted using publication data obtained from the Scopus database. The analysis presents publication trends by year and the distribution of subject areas, providing an overview of the growth, disciplinary focus, and research direction within this field.

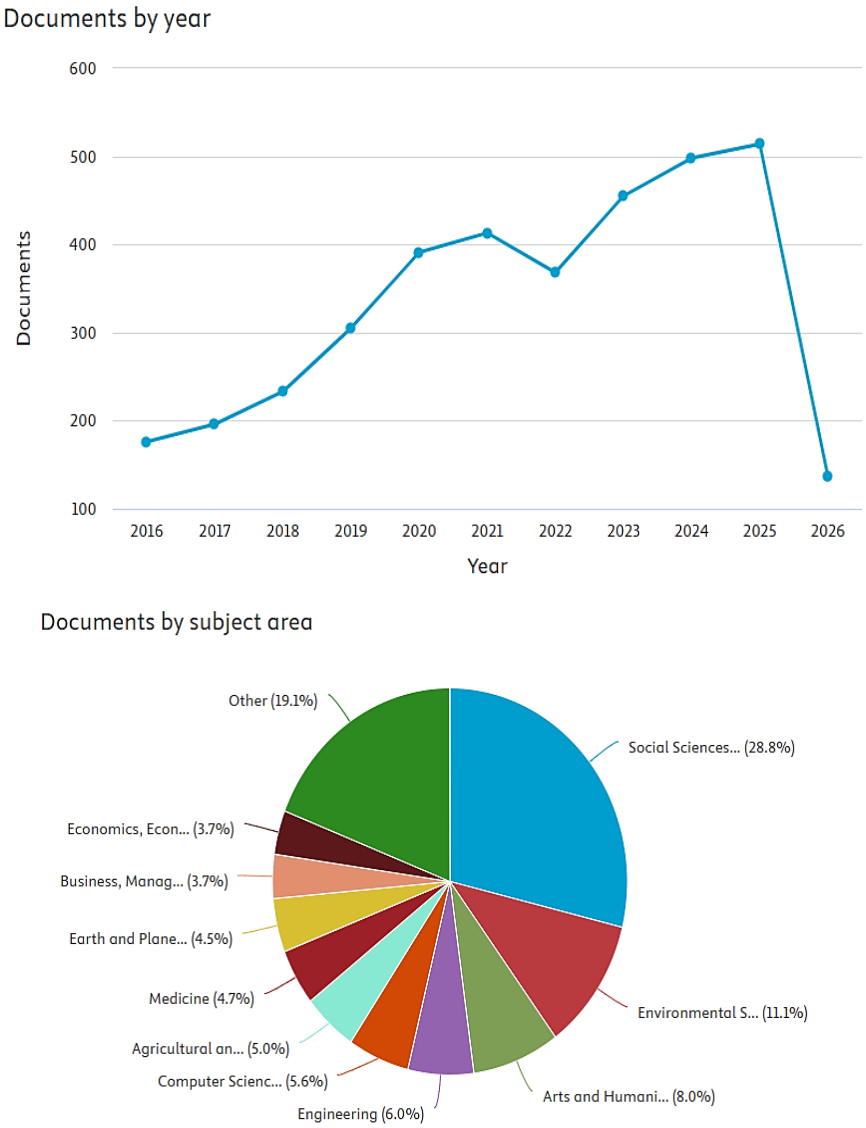

Figure 1. Trends research about socio-scientific issues (SSI) and students' environmental awareness

The visualization of publication trends indicates that research related to SSI and students' environmental awareness has shown a significant increase over the last decade on Figure 1. The number of publications steadily increased from 2016 to 2025, demonstrating growing academic interest in integrating environmental and social issues into science education. A notable rise occurred between 2018 and 2020, followed by continued growth after a slight decline in 2022. The highest number of publications was recorded in 2025,

indicating that SSI and environmental awareness have become increasingly important topics in educational and sustainability research. Meanwhile, the sharp decrease in 2026 is likely due to incomplete indexing data for the current year rather than an actual decline in research activity.

The subject area distribution further shows that research on SSI and students' environmental awareness is highly multidisciplinary. The largest contribution comes from the Social Sciences field (28.8%), highlighting the dominant focus on education, human behavior, and social dimensions of environmental issues. Environmental Science ranks second (11.1%), reflecting the strong connection between SSI and sustainability-related topics such as climate change, pollution, and environmental protection. Arts and Humanities (8.0%) also contribute substantially, indicating the importance of ethics, values, and critical thinking in SSI-based learning. In addition, contributions from Engineering, Computer Science, Agricultural Sciences, Medicine, and Earth and Planetary Sciences demonstrate that SSI research extends beyond education into technological, health, and environmental contexts. Overall, these findings suggest that research on socio-scientific issues and students' environmental awareness continues to expand across disciplines, emphasizing the importance of interdisciplinary approaches in addressing global environmental challenges through education (12-14).

Future research on SSI and students' environmental awareness is predicted to continue growing alongside increasing global concern about sustainability and environmental problems. Future studies are likely to focus more on emerging environmental issues such as climate resilience, renewable energy, carbon emissions, biodiversity conservation, and green technology within science education contexts (15-17). In addition, the integration of digital technology, artificial intelligence, virtual learning environments, and social media into SSI-based learning is expected to become an important research direction, particularly in supporting interactive and contextual environmental education.

3.2. SSI as an Approach to Promote Environmental Awareness

To examine how socio-scientific issues (SSI) contribute to the development of students' environmental awareness, a bibliometric network visualization was conducted using VOSviewer. The visualization illustrates the relationships among keywords and research themes related to SSI, environmental education, sustainability, and human behavior. Through the clustering of interconnected concepts, the mapping provides insights into the dominant topics and research directions that highlight the role of SSI as an effective approach for promoting environmental awareness in science education.

CC BY SA

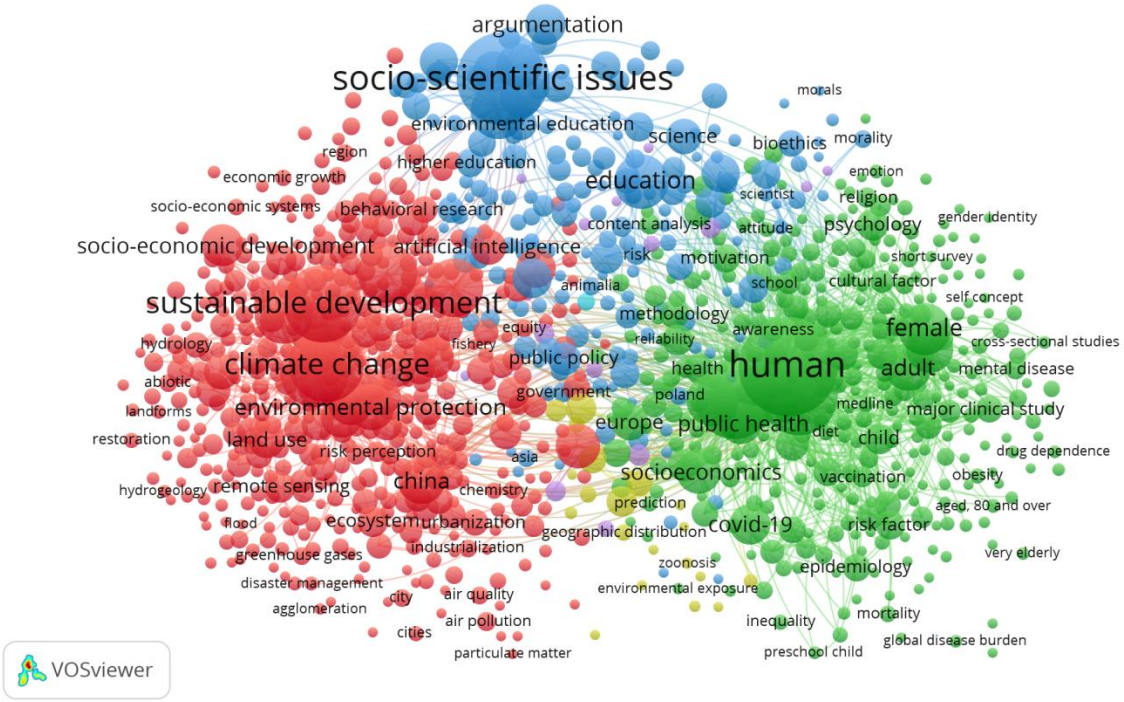

Figure 2. Bibliometric visualization using VOSviewer

Figure 2 illustrate Bibliometric visualization using VOSviewer that shows the structure of interconnected research themes on socio-scientific issues (SSI) and environmental awareness across various scientific fields. This mapping forms several main clusters representing interconnected research focuses.

1. The blue cluster centers on the keyword "socio-scientific issues," which is closely linked to terms such as education, argumentation, environmental education, science, and higher education. This indicates that SSI research is predominantly conducted in the context of science education and environmental education. The strong relationship between SSI and argumentation indicates that the SSI approach is widely used to train critical thinking, decision-making, and scientific discussion

skills related to environmental issues (18-20). The connection with environmental education demonstrates that SSI is positioned as a pedagogical strategy to increase students' environmental awareness and responsibility.

2. The red cluster is dominated by the terms "sustainable development," "climate change," "environmental protection," "land use," and "ecosystem." This cluster illustrates that SSI research is heavily linked to sustainability issues and global environmental problems, particularly climate change. The large number of climate change nodes indicates that this topic is the most frequently used environmental issue in SSI-based learning. The relationship between sustainable development and environmental protection suggests that the primary goal of SSI implementation is not only to improve understanding of scientific concepts but also to build awareness of environmental sustainability (21-23).
3. The green cluster focuses on human and social aspects, with dominant keywords such as "human," "public health," "psychology," "awareness," and "adult." This cluster demonstrates that SSI-related research highlights not only the cognitive dimension but also the psychological and behavioral dimensions of human interactions with environmental and public health issues. The presence of the term "awareness" reinforces the importance of environmental awareness as an important outcome in SSI research, particularly in relation to changes in attitudes and behaviors toward the environment.
4. Furthermore, there is a strong interconnectedness between clusters, indicating the multidisciplinary nature of SSI research. SSI is not limited to science education but is also integrated with issues of sustainability, public policy, public health, psychology, and even technological developments such as artificial intelligence (24-27). This situation demonstrates that SSI-based learning is developing as a relevant approach to addressing the complexity of modern environmental problems.

Overall, this visualization shows that research on socio-scientific issues and students'' environmental awareness is experiencing strong growth, with a primary focus on environmental education, climate change, and sustainable development. These findings support the importance of integrating SSI into science and chemistry learning to enhance environmental awareness, scientific argumentation skills, and responsible decision-making regarding sustainability issues.

3.3. Impact of SSI on Students' Environmental Awareness

The Socio-Scientific Issues (SSI) approach is a powerful educational strategy for promoting environmental awareness by integrating real-world issues into science education. This method encourages students to engage with complex, real-world problems, fostering critical thinking, scientific literacy, and a deeper understanding of environmental issues. By contextualizing learning within socio-scientific frameworks, students are better equipped to understand and address the environmental challenges they face. The following sections explore how SSI-based learning enhances environmental awareness through various educational strategies and contexts.

1. **Enhancing Cognitive and Environmental Awareness**

   SSI-based learning has been shown to effectively improve both students cognitive learning outcomes and environmental awareness. Previous studies reported that students who participated in SSI-based science learning achieved higher cognitive

performance and demonstrated greater environmental awareness compared to students taught using conventional learning methods. This finding indicates that SSI provides meaningful and contextual learning experiences that help students connect scientific concepts with real-world environmental issues. Furthermore, the integration of Problem-Based Learning (PBL), Socio-Scientific Issues (SSI), and Education for Sustainable Development (ESD) has been found to further strengthen these outcomes. Research involving high school students revealed that the PBL-based SSI-ESD approach significantly improved students chemical literacy and environmental awareness. These findings suggest that combining SSI with active and sustainability-oriented learning approaches can effectively foster students understanding, critical thinking, and environmental responsibility (28,29).

2. **Development of Critical Thinking and Environmental Literacy**
   SSI-based educational tools, such as electronic modules, have been developed to enhance students critical reasoning and environmental literacy. These tools are designed to be user-friendly and effective in promoting higher-order thinking skills, which are crucial for understanding and addressing environmental issues (30). Experiential learning courses that incorporate SSI have also been effective in changing students perceptions of environmental issues and increasing their willingness to engage in pro-environmental behaviors.
3. **Addressing Global Challenges and Sustainable Development**
   SSI-based learning is particularly relevant in the context of the Sustainable Development Goals (SDGs), as it helps students understand global challenges and develop skills such as critical thinking and problem-solving. This approach is especially beneficial for younger students, such as those in elementary schools, as it prepares them to tackle future environmental challenges (31,32).

Although most reviewed studies reported positive impacts of socio-scientific issues (SSI)-based learning on students' environmental awareness, the magnitude and consistency of these outcomes varied across educational contexts and intervention characteristics. Several studies showed stronger improvements when SSI was integrated with active learning models such as Problem-Based Learning (PBL), inquiry-based learning, and Education for Sustainable Development (ESD), particularly in secondary and higher education settings where students possess higher levels of critical reasoning and argumentation skills. In contrast, studies conducted at elementary levels generally reported more moderate outcomes, as younger students often require additional scaffolding to engage with complex socio-environmental issues.

Cultural and contextual factors also appeared to influence the effectiveness of SSI-based learning. Research conducted in regions with high exposure to environmental problems, such as climate change, waste management, or biodiversity degradation, tended to demonstrate stronger student engagement and environmental sensitivity because the issues were perceived as personally relevant. Furthermore, the duration of intervention influenced learning outcomes. Long-term SSI implementations were more likely to promote lasting environmental attitudes and pro-environmental behavior compared to short-term classroom interventions that mainly improved conceptual understanding and awareness.

Nevertheless, not all studies reported uniformly positive findings. Some studies indicated that SSI discussions could create confusion or cognitive overload when students lacked sufficient scientific background knowledge or when controversial environmental

CC BY SA

topics were insufficiently facilitated by teachers. In several cases, improvements were more evident in students' argumentation and critical thinking skills than in measurable behavioral change. These findings suggest that the effectiveness of SSI-based learning depends on multiple moderating factors, including instructional design, teacher facilitation, students' prior knowledge, cultural relevance of environmental issues, and the continuity of learning activities. Therefore, future research should focus not only on confirming the effectiveness of SSI-based learning but also on identifying optimal implementation conditions across diverse educational and sociocultural contexts.

Conclusions

This systematic literature review demonstrates that research on socio-scientific issues (SSI) and students' environmental awareness has increased significantly over the last decade, indicating growing academic attention toward integrating environmental and social issues into science education. The findings reveal that SSI-based learning is widely implemented across multidisciplinary contexts, particularly in science education, environmental education, and sustainable development studies. Climate change, sustainability, environmental protection, and scientific argumentation emerged as dominant themes in the reviewed studies.

The review also confirms that SSI-based learning positively contributes to students' environmental awareness by improving cognitive achievement, critical thinking, scientific literacy, argumentation skills, and pro-environmental attitudes. Integrating SSI with approaches such as Problem-Based Learning (PBL), Education for Sustainable Development (ESD), and digital learning tools further strengthens students understanding of environmental issues and encourages responsible decision-making related to sustainability challenges.

Acknowledgments

The authors would like to express sincere gratitude to the Department of Chemistry, Faculty of Mathematics and Natural Sciences, Makassar State University, Indonesia, for supporting this research. The authors also appreciate all researchers whose published works contributed to the completion of this systematic literature review.

Conflicts of Interest

The authors declare no conflict of interest.

References

1. Arora N, et al. Environmental sustainability: challenges and viable solutions. Environ Sustain. 2018;1:309-40. doi:10.1007/s42398-018-00038-w.
2. Lianfeng, et al. Exploring the moderating role of environmental education in promoting a clean environment. Sustainability. 2023. doi:10.3390/su15108127.
3. Al Husban W. The impact of integrating sustainable development goals on students'' awareness and pro-environmental behavior: a case study of Jordan. Sustainability. 2025;17(6):2588. doi:10.3390/su17062588.
4. Lee A. The importance of cultivating awareness of environmental matters in science classrooms: a cross-regional study. Aust J Environ Educ. 2023;39:467-91. doi:10.1017/aee.2023.7.

5. Osman A, et al. Cost, environmental impact, and resilience of renewable energy under a changing climate: a review. Environ Chem Lett. 2022;21:741-64. doi:10.1007/s10311-022-01532-8.
6. Sanchez JM, et al. Socio-scientific issues in focus: a meta-analytical review of strategies and outcomes in climate change science education. Sci Educ Int. 2024;35(2). doi:10.33828/sei.v35.i2.6.
7. Utami AD, et al. Development of global warming e-module based on Socio-Scientific Issues (SSI) to improve students'' critical thinking skills and sustainability awareness. J Penelit Pendidik IPA. 2023. doi:10.29303/jppipa.v9ispecialissue.6008.
8. Nugroho A, et al. The effects of socio-scientific inquiry based learning on students'' problem-solving skills. J Balt Sci Educ. 2025;24:149. doi:10.33225/jbse/25.24.149.
9. Tangio JS, et al. Development of an environmental problem-based learning model to improve the social-scientific reasoning of prospective chemistry teachers. J Curric Teach. 2026;15(1):436. doi:10.5430/jct.v15n1p436.
10. Herman B. Students environmental NOS views, compassion, intent, and action: impact of place-based socioscientific issues instruction. J Res Sci Teach. 2018;55:600-38. doi:10.1002/tea.21433.
11. Ariza M, et al. Socio-scientific inquiry-based learning as a means toward environmental citizenship. Sustainability. 2021;13(20):11509. doi:10.3390/su132011509.
12. Santiani, et al. Science interdisciplinary learning approach: a study interdisciplinary thinking skills and literacy environment. J Educ Learn. 2024;18(4). doi:10.11591/edulearn.v18i4.21416.
13. Priyanka LM, et al. Socio-scientific issue module based on pros and cons of using pesticides in Citrus nobilis cultivation for enhancing student's awareness in preserving the environment. J Pendidik Sains Indones. 2025;13(3). doi:10.24815/jpsi.v13i3.46943.
14. Husamah H, et al. The relationship between environmental literacy, ecological literacy, and science for sustainability: a systematic literature review. Res Dev Educ. 2025;5(1). doi:10.22219/raden.v5i1.39957.
15. Kumar V, et al. Environmental socio-scientific issues as contexts in developing scientific literacy in science education: a systematic literature review. Soc Sci Humanit Open. 2023;8:100765. doi:10.1016/j.ssaho.2023.100765.
16. Ramadanty R, et al. Contextual socio-scientific issues and education for sustainable development (SSI-ESD) climate change module: improving chemical literacy and environmental awareness among high school students in Ketapang, Indonesia. J Kependidikan. 2025;11(4). doi:10.33394/jk.v11i4.17615.
17. Hoque F, et al. Revisiting education for sustainable development: methods to inspire secondary school students toward renewable energy. Sustainability. 2022;14(14):8296. doi:10.3390/su14148296.
18. Sari DR, et al. A systematic review on integrating SSI into science education: its impact on 21st century skills (2014-2024). Educ Stud Res J. 2025. doi:10.60036/sa6n0870.
19. Türk CK, Çam A. The effect of argumentation on middle school students' scientific literacy as well as their views, attitudes and knowledge about socioscientific issues. Sci Educ. 2024;34:1363-88. doi:10.1007/s11191-023-00489-6.
20. Wang HH, et al. The impact of socio-scientific issue discussions on student environmentalism. Eurasia J Math Sci Technol Educ. 2018. doi:10.29333/ejmste/95134.

21. Högström P, et al. Teaching socioscientific issues: a systematic review. Sci Educ. 2024;34:3079-122. doi:10.1007/s11191-024-00542-y.
22. Nofiana M, et al. Socioscientific issue-based science learning: how it relates to sustainable education? J Curric Teach. 2025;14(3):272. doi:10.5430/jct.v14n3p272.
23. Cadena-Nogales PD, et al. Relationships between preservice teachers' interest, perceived knowledge, and argumentation in socioscientific issues: implications for teaching about the complexity of sustainability challenges. Sustainability. 2025;17(9):3860. doi:10.3390/su17093860.
24. Zeidler D, et al. New directions in socioscientific issues research. Discip Interdiscip Sci Educ Res. 2019;1. doi:10.1186/s43031-019-0008-7.
25. Schenk L, et al. Socioscientific issues in science education: an opportunity to incorporate education about risk and risk analysis? Risk Anal. 2021;41:1-11. doi:10.1111/risa.13737.
26. Karışan D, Zeidler D. Teaching socioscientific issues in the digital age: emerging trends and unexplored frontiers. Turk J Educ. 2024. doi:10.19128/turje.1384524.
27. Yılmaz AA. Artificial intelligence integration and social innovation: interdisciplinary research trends aligned with the sustainable development goals. Sosyal Mucit Acad Rev. 2024. doi:10.54733/smar.1543390.
28. Apema E, Suzanti F, Azhar A. Implementation of science learning oriented to socio-scientific issues on ecology and biodiversity material in Indonesia to improve learning outcomes and environmental awareness attitudes. J Penelit Pendidik IPA. 2025;11(8):1255-62. doi:10.29303/jppipa.v11i8.11699.
29. Putri SW, Handayani S, Ramadanty R. Integrating problem-based learning and SSI-ESD context to foster chemical literacy and environmental awareness in secondary education. J Pendidik MIPA. 2025;26(3):1988-2002. doi:10.23960/jpmipa.v26i3.pp1988-2002.
30. Akhnah AM, Subiantoro AW. Troso e-module based on SSI to enhance students reasoning thinking dimensions and environmental literacy. J Pendidik Biol Indones. 2025;11(2):706-15. doi:10.22219/jpbi.v11i2.39892.
31. Solihin A, Suryanti, Susiyawati E, Julianto, Susantini E, Puspita AMI. Integrating socio-scientific issues (SSI) approach based on SDGs for generation alpha in elementary schools. J Cakrawala Pendas. 2025;11(3):763-74. doi:10.31949/jcp.v11i3.13396.
32. Auliah A, Allo EL, Fadly D, Islawati I, Halisah N, Rahma R. Improving students understanding of chemistry concepts and environmental sensitivity through the implementation of the project-based learning (PJBL) model based on the socio-scientific issue (SSI) approach. East Asian J Multidiscip Res. 2025;4(9):4499-514. doi:10.55927/eajmr.v4i9.377.

CC BY-SA 4.0 (Attribution-ShareAlike 4.0 International).
This license allows users to share and adapt an article, even commercially, as long as appropriate credit is given and the distribution of derivative works is under the same license as the original. That is, this license lets others copy, distribute, modify and reproduce the Article, provided the original source and Authors are credited under the same license as the original.