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Socio-Scientific Issues and Local Wisdom in Science Education: A Literature Review of Critical Thinking and Cultural Literacy

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Abstract: Science learning needs to develop students' critical thinking skills and cultural literacy. Socio-Scientific Issues (SSI) link scientific concepts with social issues to encourage investigation, argument evaluation, and evidence-based decision-making, while local wisdom connects learning with students' social and cultural contexts. This study aims to synthesize previous research on SSI and local wisdom in science learning and to map their contributions to critical thinking skills and cultural literacy. A literature review was conducted using narrative thematic synthesis of eight articles selected from database names and published mainly between 2021 and 2026 (one earlier article from 2019 was retained as a foundational SSI study). The synthesis shows a tendency for SSI-based learning to support critical thinking skills, particularly identifying problems, evaluating arguments, and making decisions, and for local wisdom-based learning to support cultural literacy by helping students recognize, appreciate, and apply cultural values. However, none of the eight articles examined SSI and local wisdom together in a single intervention, and much of the evidence comes from development studies reporting feasibility. The integration of SSI and local wisdom therefore remains a development opportunity that requires further empirical testing. This review contributes a map of the available evidence, its limitations, and directions for integrating the two approaches in science learning.

Keywords: Critical thinking; Cultural literacy; Local wisdom; Science learning; Socio-Scientific Issues

Introduction

Learning Natural Sciences (IPA) plays a crucial role in equipping students with the ability to understand various natural phenomena and address emerging challenges in everyday life. Advances in science and technology require students to master not only conceptual knowledge but also the ability to analyze information, evaluate evidence, construct arguments, and make informed decisions. These skills are becoming increasingly important because many issues in society are often related to scientific concepts and have social, economic, environmental, and cultural dimensions. Therefore, science learning needs to be directed toward contextual learning experiences that connect scientific concepts to real-world problems in the student's environment.

One approach that can be used to achieve these goals is *Socio-Scientific Issues* (SSI). SSI is a learning approach that raises social issues related to scientific concepts, particularly issues that are controversial, dilemmatic, and open-ended, so they do not always have one absolute answer. These characteristics provide opportunities for students to identify problems, conduct investigations, consider various perspectives, evaluate arguments, and make decisions based on scientific evidence. Sofiana (2019) showed that the SSI approach has a positive influence on improving students' critical thinking skills. In line with this, Hasibuan and Sugiharti (2025) found that an SSI-based e-module on reaction rates was declared valid and practical and was able to improve students' critical thinking skills.

In addition to fostering critical thinking skills, the SSI approach can also increase student engagement in learning. Raqzitya and Agung (2022) conducted research on SSI-based interactive e-modules, demonstrating that the use of these e-modules can increase student engagement and help them understand science concepts contextually. This demonstrates that SSI has the potential to transform science learning from one focused on mastering concepts to one that encourages students to connect scientific concepts with real-world problems.

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However, the implementation of SSI needs to consider the context of students' lives so that the issues studied are not abstract and detached from their socio-cultural environment. One approach that can strengthen this contextualization is the integration of local wisdom. Sudarmin et al. (2020) and Zulfa et al. (2024) explain that science learning can involve local culture and wisdom found in the surrounding environment to build students' curiosity and ability in learning science. Furthermore, Supriatna et al. (2025) state that a local wisdom approach in science learning can strengthen the understanding of scientific concepts while instilling local cultural values in students.

The integration of local wisdom also plays a crucial role in developing students' cultural literacy. Rahman et al. (2022) stated that developing learning modules based on local wisdom values can help students learn more independently, think critically and creatively, and develop attitudes, knowledge, and skills. Furthermore, utilizing local wisdom values in learning contributes to preserving culture as a regional identity. Similarly, Wahyudi et al. (2025) emphasized the importance of developing electronic modules based on local wisdom values in science learning to improve students' cultural literacy and critical thinking skills.

The relationship between local wisdom and science learning is also evident in the ethnoscience approach. Maria et al. (2025) demonstrated that ethnoscience-based e-modules are feasible and capable of improving students' learning motivation and scientific literacy. Meanwhile, Ali et al. (2025) found, through *a Systematic Literature Review*, that the ethnoscience approach is effective in improving students' critical thinking skills, scientific literacy, and understanding of local culture. These findings strengthen the argument that integrating local knowledge and culture into science learning can provide a more meaningful and contextual learning experience.

One form of local wisdom that has the potential to be integrated into science learning is Maudu Lompoa. Research by Sijabat et al. (2024) on teaching materials based on Maudu Lompoa local wisdom values showed that these teaching materials were effective in improving students' conceptual understanding and cultural literacy. Furthermore, Wahyudi (2025) through the development of electronic modules based on Maudu Lompoa local wisdom values demonstrated its effectiveness in improving students' cultural literacy and critical thinking skills. Kurniawati and Wilujeng (2022) also found that science learning based on Maudu Lompoa local wisdom values can improve students' scientific literacy and environmental awareness.

Conceptually, SSI and local wisdom are connected through the issues that serve as the learning context. Local cultural practices, such as traditions involving food, natural resources, health, or environmental management, contain scientific phenomena and, at the same time, raise social, ethical, and environmental questions on which people may hold different views. When such practices are used as SSI issues, students need to analyze the scientific concepts involved, evaluate evidence and competing arguments, and consider cultural values before reaching a decision, which supports critical thinking. The same context allows students to understand, interpret, and appreciate local cultural values, which supports cultural literacy. In this relationship, SSI provides the analytical process, whereas local wisdom provides the cultural content and meaning. This is a conceptual proposition drawn from the literature, and its empirical support still needs to be examined.

Although numerous studies have demonstrated the benefits of SSI and local wisdom in science learning, the two have generally been studied separately. Among the studies discussed above, SSI research (Sofiana, 2019; Raqzitya & Agung, 2022; Hasibuan & Sugiharti, 2025) centers on critical thinking and engagement, whereas local wisdom and ethnoscience research (Sijabat et al., 2024; Kurniawati & Wilujeng, 2022; Maria et al., 2025; Wahyudi, 2025) centers on conceptual understanding, scientific literacy, cultural literacy, or environmental awareness. The two lines of research therefore address different competencies and seldom the same learners at the same time. Nevertheless, these studies have not been compared systematically to show how far the integration of SSI and local wisdom has been investigated, which outcomes were measured, and how strong the evidence is. A synthesis is needed to map this evidence before integrated learning designs are developed and tested.

Based on the above description, this article aims to (1) map the forms in which SSI and local wisdom have been applied in science learning in the reviewed articles; (2) synthesize the contribution of each approach to students' critical thinking skills and cultural literacy, distinguishing evidence from measured learning outcomes from evidence based on feasibility or perception; and (3) identify the limitations of the available evidence and the opportunities for integrating SSI and local wisdom in science learning. The contribution of this review lies in the pattern of results, the limits of the evidence, and the opportunities for integration that it identifies.

Method

This study uses a literature review method *to* analyze the results of previous research on the integration of *Socio-Scientific Issues* (SSI) and local wisdom in science learning, particularly in relation to

students' critical thinking skills and cultural literacy. The study was conducted by searching, selecting, reviewing, and synthesizing various scientific articles relevant to the research focus.

Literature Search Strategy

The literature search was conducted in name the databases or platforms actually used, e.g., Google Scholar, Scopus, ERIC, DOAJ, Garuda for publications from 2021 to 2026 state the search date. Keywords were combined with Boolean operators, for example: ("socio-scientific issues" OR SSI) AND ("local wisdom" OR ethnoscience) AND ("science learning" OR "science education") AND ("critical thinking" OR "cultural literacy"). Additional searches paired each approach separately with each competency (e.g., SSI AND "critical thinking"; "local wisdom" AND "cultural literacy") and used the term "Maudu Lompoa". Earlier sources were used only as a conceptual basis, except for one article from 2019 explained in the next section.

Article Selection Criteria

Articles were included if they (1) were published in peer-reviewed journals between 2021 and 2026; (2) were empirical studies (development, experimental, or quasi-experimental research) or systematic reviews; (3) examined SSI or local wisdom/ethnoscience in science learning at the school level; (4) reported outcomes related to critical thinking skills, cultural literacy, or closely related competencies (e.g., scientific literacy, engagement); and (5) were relevant to the study objectives. Articles were excluded if they did not address science learning, did not report learning outcomes or findings related to the focus, or were not accessible in full text.

One article from 2019 (Sofiana, 2019) falls outside the publication period and was retained as an exception because it reports direct evidence of the effect of the SSI approach on high school students' critical thinking. Each article was classified into one of three groups: SSI, local wisdom/ethnoscience, or integration of both, so that conclusions do not exceed the evidence available for each group.

Analysis Procedure

Literature analysis was conducted in five stages: identification, selection, information extraction, analysis, and synthesis. In the identification stage, articles were collected using the predetermined keywords. Selection was then conducted in steps, from the suitability of the title and abstract to full-text reading against the criteria above and was documented using the PRISMA 2020 flow diagram format (Figure 1). Relevant information was extracted, including the author's name, year of publication, research objectives, research design, subject characteristics and educational level, form of SSI or local wisdom integration, and findings related to critical thinking skills and cultural literacy.

The extracted data were analyzed using narrative thematic synthesis. Findings were first grouped by approach (SSI, local wisdom/ethnoscience, or integration of both), and then compared across study designs, educational levels, and the type of outcome reported to identify similarities, differences, trends, and gaps. Conclusions were drawn at the level of the evidence: a pattern is described as a tendency when it is reported consistently across articles, and claims about integration are limited to what the articles examined.

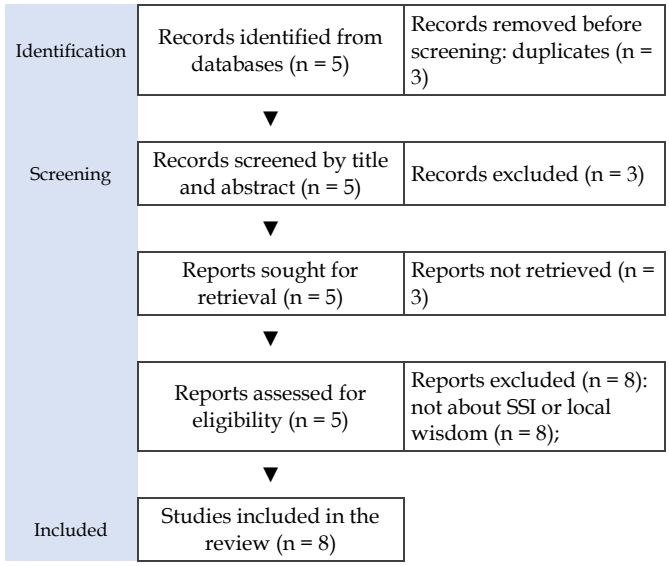

Figure 1. PRISMA 2020 flow diagram of article selection

Analysis Categories and Synthesis Focus

The synthesis focused on three aspects: (1) the form of application of SSI and local wisdom in science learning, (2) their contribution to critical thinking skills, and (3) their contribution to students' cultural literacy. Contributions to critical thinking were categorized using the indicators interpretation, analysis, evaluation, inference, and evidence-based argumentation, while contributions to cultural literacy were categorized as understanding, interpreting, appreciating, and applying cultural values; categories were matched to the indicators reported in each source article. For each finding, the type of evidence was also recorded, namely measured learning outcomes versus feasibility (validity and practicality) or perception.

A literature review was chosen because SSI has been widely studied in relation to critical thinking, whereas local wisdom has been used to support cultural literacy and conceptual understanding, and a review is needed to map what is known about these two lines of research, and where the evidence is missing, before integrated learning designs are developed and tested.

Result and Discussion

Result

Based on the literature search and selection (Figure 1), eight articles were obtained. By focus, three articles examined SSI (Sofiana, 2019; Raqzitya & Agung, 2022; Hasibuan & Sugiharti, 2025) and five examined local wisdom or ethnoscience (Sijabat et al., 2024; Kurniawati & Wilujeng, 2022; Maria et al., 2025; Wahyudi, 2025; Ali et al., 2025); none examined SSI and local wisdom together in a single intervention. The articles comprised development studies, experimental and quasi-experimental studies, and one systematic literature review. Each article was analyzed by its identity, focus, design and subjects, and reported results, as shown in Table 1.

Table 1. Summary of Reviewed Articles

Author (Year)	Focus	Design and subjects	Main findings
Hasibuan & Sugiharti (2025)	SSI	Development research; senior high school (e-module on reaction rate)	E-module declared valid and practical; improved critical thinking skills.
Raqzitya & Agung (2022)	SSI	Development research; junior high school (interactive e-module)	Increased student engagement; helped students understand science concepts contextually.
Sijabat et al. (2024)	Local wisdom (Maudu Lompoa)	Experimental study; junior high school (teaching materials)	Improved conceptual understanding and cultural literacy.
Maria et al. (2025)	Local wisdom (ethnoscience)	Development research; junior high school (e-module)	E-modules were feasible and improved learning motivation and scientific literacy.
Ali et al. (2025)	Local wisdom (ethnoscience)	Systematic literature review; educational level not specified	Ethnoscience contributed to critical thinking, scientific literacy, and understanding of local culture.
Wahyudi (2025)	Local wisdom (Maudu Lompoa)	Development/experimental study; junior high school (electronic module)	Improved cultural literacy and critical thinking skills.
Sofiana (2019)	SSI	Experimental study; senior high school	SSI approach had a positive influence on critical thinking skills.
Kurniawati & Wilujeng (2022)	Local wisdom (Maudu Lompoa)	Quasi-experimental study; junior high school	Improved scientific literacy and environmental awareness.

Table 1 shows that the reviewed studies applied SSI and local wisdom through various forms, ranging from learning approaches and teaching materials to e-modules. SSI-based studies focus on critical thinking skills and engagement, whereas studies based on local wisdom and ethnoscience report contributions to scientific literacy, conceptual understanding, cultural literacy, and environmental awareness. Findings on e-modules indicate that digital media can increase engagement and provide a more contextual learning experience. Notably, none of the eight articles combined SSI and local wisdom in a single intervention; the evidence on integration is therefore inferential, drawn from separate lines of research, rather than demonstrated directly.

To obtain a more comprehensive overview of research trends, the articles were synthesized to identify general patterns in the contribution of SSI and local wisdom to critical thinking skills and cultural literacy, and to examine the potential of e-modules as an integration medium. The results are presented in Table 2.

Table 2 shows that SSI and local wisdom are each associated with cognitive and socio-cultural aspects of students. SSI is more consistently used to develop critical thinking skills, while local wisdom provides a context that supports cultural literacy and the understanding of science concepts. E-modules have the potential to carry both approaches in an interactive and contextual medium. These patterns come from separate studies and should not be read as evidence that the combination is effective; they are consistent with previous studies showing that culture-based approaches can increase engagement, critical thinking, and awareness of cultural values.

Table 2. Synthesis of Literature Review Findings

Aspects Studied	General Findings from the Literature
Socio-Scientific Issues (SSI)	SSI can connect science concepts with real issues that are controversial, dilemmatic, and open so that students are encouraged to conduct investigations, evaluate information, and make decisions based on scientific considerations.
Critical thinking	SSI integration encourages critical thinking skills through activities such as identifying problems, analyzing information, evaluating arguments, considering evidence, and making decisions.
Local wisdom	Local wisdom can be used as a learning context that connects science concepts with traditions, knowledge, the environment, and community life practices.
Cultural Literacy	Integration of local wisdom helps students recognize, understand, appreciate, and apply cultural values and strengthen local cultural identity.
Contextuality of Learning	SSI and local wisdom make learning more contextual because science concepts are linked to social, cultural, environmental issues and students' life experiences.
Student Involvement	The use of real issues and local cultural contexts encourages students to be more active, participatory, and motivated in the learning process.
21st Century Skills	The integration of SSI and local wisdom has the potential to support critical thinking skills, problem solving, decision making, communication, and the ability to connect knowledge to real life.
Maudu Lompoa	Maudu Lompoa has potential as a science learning context because it can connect scientific concepts with local cultural values, practices, and identities and supports cultural literacy and critical thinking.
E-Module	E-modules have been used in separate SSI and ethnoscience studies as a medium that can combine text, images, videos, infographics, cases, investigative activities, and interactive evaluations.
Learning Effectiveness	In general, SSI, ethnoscience, local wisdom, and e-modules show a tendency to have a positive impact on various student competencies, especially critical thinking, literacy, conceptual understanding, and learning engagement.
Implementation Barriers	Implementation still faces obstacles in the form of limited locally based learning resources, teacher readiness, and the lack of systematic guidance for integrating cultural contexts and socio-scientific issues into learning.
Research Gap	None of the eight reviewed articles examined SSI and local wisdom together. The simultaneous integration of SSI and Maudu Lompoa local wisdom, targeting critical thinking and cultural literacy, therefore remains an opportunity that requires empirical testing.

Discussion

Integration of SSI in the Development of Critical Thinking Skills

The reviewed studies indicate that SSI-based learning tends to support students' critical thinking skills. The characteristics of SSI, which presents real-life, controversial, and open-ended problems, give students opportunities not only to understand scientific concepts but also to analyze them from multiple perspectives. Students are required to identify problems, seek relevant information, consider evidence, evaluate arguments, and make decisions.

This is evident in Sofiana's (2019) research, which reported a positive influence of the SSI approach on critical thinking skills. Similar results were reported by Hasibuan and Sugiharti (2025) in the development of an SSI-based e-module, which was found to be valid and practical and capable of improving students' critical thinking skills.

SSI features can be linked to critical thinking indicators. Reading and understanding the issue and its data corresponds to interpretation; breaking the issue into scientific, social, and ethical components corresponds to analysis; judging the credibility of sources and competing claims corresponds to evaluation; drawing conclusions about consequences from the evidence corresponds to inference; and justifying a position with scientific evidence corresponds to evidence-based argumentation. This mapping is conceptual, and the reviewed articles need to be examined further to determine which indicators each study actually measured.

The type of evidence also differs between studies. Sofiana (2019) addressed the influence of the SSI approach on critical thinking directly. Hasibuan and Sugiharti (2025) established the validity and practicality of an e-module and reported improved critical thinking, so their evidence combines feasibility and learning outcomes. Raqzitya and Agung (2022) reported engagement and contextual understanding rather than critical thinking. The support for the contribution of SSI to critical thinking is therefore stronger where studies measured critical thinking directly and more limited where it rests on feasibility or engagement.

Overall, the characteristics of SSI align with the demands of 21st-century learning because the learning process positions students as decision-makers regarding the problems being studied, which gives space for analytical, evaluative, argumentative, and decision-making skills.

Local Wisdom as a Context for Cultural Literacy

Unlike SSI, which has been studied mainly in relation to critical thinking, local wisdom has mainly

been used to provide cultural context to learning. It allows students to learn science concepts through phenomena and practices relevant to their lives. Research by Sijabat et al. (2024) shows that teaching materials based on Maudu Lompoa local wisdom values effectively improve conceptual understanding and cultural literacy. Meanwhile, Kurniawati and Wilujeng (2022) show that science learning based on Maudu Lompoa values can improve scientific literacy and environmental awareness. These findings indicate that local wisdom can be used not only as illustration in learning but also as a context that helps students understand the relationship between science and social life, and that it can support the strengthening of cultural identity and literacy.

Cultural literacy was reported directly in three of the eight articles: Sijabat et al. (2024), Wahyudi (2025), and, as understanding of local culture, Ali et al. (2025). The other local wisdom studies reported scientific literacy, learning motivation, or environmental awareness (Kurniawati & Wilujeng, 2022; Maria et al., 2025). The aspects most often addressed are therefore understanding of, and appreciation for, local culture, while the ability to critically interpret and apply cultural values is less visible in the reviewed articles. How cultural literacy is defined and measured also needs to be reported more clearly in future studies, so that findings can be compared across studies.

The Potential of Maudu Lompoa in Science Learning

One finding from the literature is the potential of Maudu Lompoa as a science learning context. Three of the eight articles used Maudu Lompoa (Sijabat et al., 2024; Wahyudi, 2025; Kurniawati & Wilujeng, 2022) and reported benefits for scientific literacy, conceptual understanding, cultural literacy, and critical thinking. Sijabat et al. (2024) and Wahyudi (2025) show that Maudu Lompoa values can be integrated into teaching materials and electronic modules.

Conceptually, this potential becomes more relevant when Maudu Lompoa is linked to SSI, because cultural phenomena can serve as a starting point for presenting problems that can be analyzed scientifically. Students could then consider the consequences of various choices based on scientific, social, environmental, health, and cultural aspects. None of the reviewed studies tested this combination.

Maudu Lompoa can thus be proposed as a bridge between scientific knowledge and cultural knowledge, making science learning more relevant to students' realities while maintaining the goal of developing scientific competence.

E-Modules as Integration Media

The reviewed studies also indicate that e-modules have potential as a medium for SSI and local wisdom. Raqzitya and Agung (2022) reported that interactive SSI-based e-modules can increase student engagement and facilitate contextual understanding, and Maria et al. (2025) reported that ethnoscience-based e-modules are feasible and can improve learning motivation and scientific literacy.

The advantage of e-modules lies in their ability to bring various media forms, investigative activities, prompting questions, and evaluations into a single learning flow. E-modules are therefore a possible medium for future integrated designs.

Integration of SSI and Local Wisdom as Contextual Learning

Based on the overall findings, SSI and local wisdom appear conceptually complementary. SSI provides problems or dilemmas that need to be analyzed, while local wisdom provides the social and cultural context that makes these issues relevant to students. Integrating the two could connect scientific knowledge with social and cultural realities, so that students use science concepts to understand issues in their communities. This complementarity is inferred from separate studies and has not yet been tested directly.

In the context of Maudu Lompoa, an integrated design could follow this sequence: presentation of a cultural phenomenon, problem identification, investigation of science concepts, evaluation of information and arguments, decision-making, and reflection on cultural values. This sequence is consistent with the inquiry, argumentation, evaluation, and decision-making emphasized in SSI.

Contribution of the Review and Research Opportunities

The review shows that previous research provides an empirical basis for the benefits of SSI and local wisdom separately. SSI research predominantly reports improvements in critical thinking, while research on local wisdom and ethnoscience reports improvements in scientific literacy, conceptual understanding, cultural literacy, and environmental awareness. E-modules have been used as a medium in both lines of research.

The contribution of this review can be summarized in three points. First, it maps the evidence: of the eight articles analyzed, three focused on SSI, five on local wisdom or ethnoscience, and none on their integration. Second, it identifies the limits of the evidence: the studies differ in design and outcome measures, several report feasibility rather than measured learning outcomes, and cultural literacy is directly reported in only some of them. Third, it supports recommendations for integration in science learning, noting that local wisdom-based learning still faces limited learning

resources, limited teacher readiness, and a lack of systematic integration guidelines. These statements are limited to the eight articles analyzed, and the small corpus is a limitation of this review.

These findings point to a research opportunity: designing and testing learning that integrates SSI with local wisdom such as Maudu Lompoa, for example through e-modules, with critical thinking skills and cultural literacy measured in the same study. This opportunity is distinct from the findings of the review itself and requires empirical testing.

Conclusion

This literature review indicates a tendency for SSI to support students' critical thinking skills and for local wisdom-based learning to support cultural literacy in science learning. SSI encourages students to analyze problems, evaluate evidence and arguments, and make decisions, while local wisdom helps connect science concepts with culture and real life. Maudu Lompoa appears to be a promising learning context for cultural literacy and critical thinking. However, none of the eight analyzed articles examined the integration of SSI and local wisdom directly, and part of the evidence concerns feasibility rather than measured outcomes. Integration therefore remains an opportunity rather than a proven approach. Further research is recommended to develop and test learning, including e-modules, that integrates SSI with Maudu Lompoa local wisdom, focusing on validity, practicality, and effectiveness for critical thinking skills and cultural literacy.

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Conceptualization, X.X. and Y.Y.; methodology, X.X.; validation, X.X., Y.Y., and Z.Z.; formal analysis, X.X.; investigation, X.X.; resources, X.X.; data curation, X.X.; writing—original draft preparation, X.X.; writing—review and editing, Y.Y.; visualization, X.X.; supervision, Z.Z.; project administration, X.X.; funding acquisition, Y.Y.. All authors have read and agreed to the published version of the manuscript.

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