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Integration of local potential and innovative learning methods to improve environmental awareness: A systematic literature review

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ABSTRACT
This study aimed to examine the integration of local potential and innovative learning methods to improve environmental care attitudes. In response to global issues such as climate change, pollution, and ecosystem degradation, it is essential to increase environmental awareness through education. Local potential—including traditional wisdom, indigenous practices, and biodiversity—is used as a relevant, contextual learning resource. Innovative learning methods such as project-based learning (PBL), problem-based learning, and collaborative learning are applied to enhance learner engagement and understanding. This systematic literature review analyses articles published between 2014 and 2024 in reputable national and international journals, using the PRISMA framework. The findings reveal that integrating local potential and innovative learning methods significantly enhances students' attitudes toward environmental care, including improvements in critical thinking, conservation character development, and the application of local knowledge. Implementation challenges are identified, and best-practice recommendations are provided to strengthen environmental education. This study contributes to the development of effective and contextually relevant educational strategies that foster a generation more responsible for environmental sustainability.

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Introduction

A healthy and sustainable environment is a fundamental necessity for human life and the well-being of future generations. However, in recent decades, global environmental degradation has intensified due to complex challenges, including climate change, pollution, biodiversity loss, and ecosystem disruption. These issues threaten not only natural systems but also the social and economic

stability of communities worldwide (Moklis et al., 2020; Hermawan & Mahmudah, 2023). Therefore, raising environmental awareness and promoting sustainable behaviors among individuals has become a critical global priority.

Education plays a pivotal role in addressing these challenges by equipping learners with the knowledge, skills, and attitudes necessary for effective environmental management and protection. According to Sadi and Dagyar (2022), innovative science learning approaches that incorporate context-based instruction foster both environmental awareness and scientific literacy among learners. Integrating local potential—including indigenous wisdom, traditional environmentally friendly practices, and unique regional biodiversity—into educational frameworks creates a meaningful, contextualized learning experience (Kabani, 2023; Wardani & Miftakhi, 2021). This integration fosters learners' connection to their cultural and natural heritage, allowing them to appreciate the interplay between local realities and broader global environmental issues (Miko, 2023).

Innovative learning methods such as project-based learning (PjBL), problem-based learning, and collaborative learning further enrich the educational process by actively engaging pupils, stimulating critical thinking, creativity, and collaborative problem-solving (Nurasiah et al., 2022; Rahmi et al., 2023*)*. The use of information and communication technology (ICT) broadens access to information and enhances opportunities for global collaboration (Novita, 2022). Together, these approaches not only improve academic understanding but also cultivate responsible attitudes and behaviors toward environmental stewardship (Khoiri & Peterianus, 2021; Munawaroh et al., 2022).

Globally, similar educational initiatives have demonstrated the effectiveness of integrating local knowledge with innovative pedagogical approaches to prepare learners as active agents of environmental sustainability. These approaches enable learners to contextualize global environmental challenges through the lens of their local environment and culture, thereby strengthening both local identity and global citizenship (Kabani, 2023; Wardani & Miftakhi, 2021; Yıldırım & Aydın, 2021).

In Indonesia, with its rich natural resources and cultural diversity, integrating local potential into education is particularly valuable. Programmes such as Adiwiyata have contributed to embedding environmental values and sustainable practices in schools, while innovative teaching practices have enhanced pupil engagement and learning outcomes (Moklis et al., 2020; Hermawan & Mahmudah, 2023). Developing teaching materials that highlight local contexts and environmental issues has shown positive impacts on learners' environmental awareness and behavior (Khoiri & Peterianus, 2021).

Therefore, it is essential to explore how these approaches are implemented at the school level and assess their impact on students' environmental awareness and attitudes toward environmental care. This study aims to investigate various school-level educational approaches that integrate local potential with innovative learning methods. Furthermore, it seeks to evaluate the effects of these approaches on students' environmental awareness and their attitudes toward environmental stewardship. Specifically, the study aims to: (1) Examine a variety of educational approaches at the school level that combine local potential with innovative learning methods, and (2) Assess the impact of these approaches on students' environmental awareness and their attitudes toward environmental care. By addressing these objectives, the study aims to provide valuable insights into how integrating local wisdom with modern pedagogical innovations can strengthen environmental education and cultivate a generation capable of sustainable environmental management and protection.

Methods

This study employed a systematic literature review (SLR) following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework to ensure a rigorous, transparent, and systematic approach to identifying, selecting, and synthesizing relevant studies. The review protocol followed the PRISMA guidelines developed by Moher et al. (2009), which have been widely adopted for reporting systematic reviews. To align the methodology with current best practices, this study also adopted the updated PRISMA 2020 Statement (Page et al., 2021).

Accordingly, the review was conducted through four sequential stages: identification, screening, eligibility, and inclusion.

Data Sources and Keywords

The literature search was conducted using the Publish or Perish application, accessing reputable databases such as Scopus and Google Scholar. Specific keywords were used to retrieve relevant articles, including "local potential," "innovative learning methods," "environmental education," "environmental awareness," "environmental care attitudes," and "sustainability education." These keywords were combined using Boolean operators to refine the search results and ensure coverage of the study's thematic scope.

Inclusion and Exclusion Criteria

Inclusion criteria for selecting articles were: 1) Published in accredited national and international journals; 2) Published within the last ten years (2014–2024); 3) Articles focusing on educational approaches that integrate local potential with innovative learning methods in environmental education; 4) Empirical studies providing data on the impact of such approaches on environmental awareness or attitudes. Exclusion criteria included: 1) Articles not available in full text; 2) Studies outside the scope of education or environmental topics; 3) Review articles without empirical data; and 4) Publications prior to 2014.

Article Selection and Profile

The initial database search identified 76 records from Scopus, Google Scholar, and other relevant sources. After the removal of duplicate and clearly irrelevant records, 50 articles proceeded to the title and abstract screening stage. Subsequently, 25 full-text articles were assessed for eligibility, and 18 studies met all inclusion criteria and were included in the final review. A detailed description of the article screening and selection process is presented in Appendix A.

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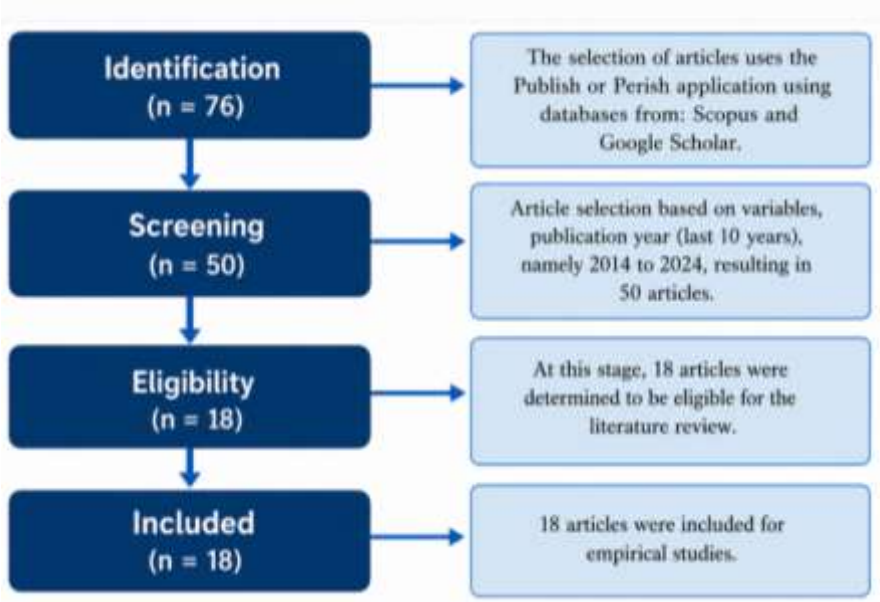
Data Analysis

The analysis of the selected articles involved qualitative synthesis and thematic analysis. This process included coding the content related to types of educational approaches, integration of local potential, learning innovations, and observed impacts on learners' environmental awareness and attitudes. The thematic analysis helped identify common patterns, successes, challenges, and gaps in the existing literature, enabling a critical evaluation of the effectiveness of various educational strategies.

This methodological approach provides a structured and evidence-based understanding of how integrating local potential with innovative learning methods influences environmental education outcomes. The process of reviewing articles using the PRISMA framework can be seen in Figure 1 below.

Figure 1

Prism framework flow chart



Note. Adapted from Zarate et al., 2022

Findings

The findings of this systematic literature review are organized in alignment with the study objectives: (1) to examine diverse educational approaches integrating local potential and innovative learning methods, and (2) to evaluate their impact on students' environmental awareness and attitudes toward caring for the environment.

Educational Approaches Integrating Local Potential and Innovative Learning Methods

Table 1 summarizes the major findings of the 18 reviewed articles, highlighting the key educational approaches and their primary outcomes. The table has been simplified to focus on the main themes, such as types of integration, learning methods applied, and their educational impacts. The results of the review of the 18 selected articles are shown in Table 1 below. The complete characteristics of all reviewed studies are presented in Appendix B

Table 1

Summary of reviewed articles on integration of local potential and innovative learning in environmental education

No.	Author(s) (Year)	Educational Approach	Major Findings
1	Woro Sumarni (2023)	Integration of ethnosciences in STEM and Project-Based Learning (PjBL)	Improvement in 4C skills (Critical thinking, Creativity, Collaboration, Communication); development of conservation character; application of local knowledge in problem-solving
2	Marlina et al. (2015)	Environmental knowledge modules based on local context	Enhanced environmental awareness and care attitudes

No.	Author(s) (Year)	Educational Approach	Major Findings
3	Kahar et al. (2018)	Development of biology learning tools based on local potential and environmental literacy	Effective in improving biology understanding and raising environmental awareness and conservation attitudes
4	Sriyati et al. (2021)	Biotechnology learning tools based on local potential	Improved theoretical understanding, practical skills, and appreciation of local culture
5	Suryaningsih (2018)	Ecotourism activities as active learning	Increased environmental concern and awareness through direct nature experience
6	Dwika et al. (2024)	Integration of local potential in biotechnology learning	Enhanced education quality and student motivation
7	Bakhtiar (2016)	Teaching materials based on local wisdom and STEM	Increased student interest and learning outcomes
8	Azizah et al. (2020)	I-SETS-based teaching materials (Integrative Science, Environment, Technology, Society)	Positive contribution to character development, including religious values, curiosity, social and environmental care
9	Hastutiningsih et al. (2016)	Outdoor learning guides based on direct experience	Development of environmental care character and ecological understanding through interactive activities
10	Gunawan R.D. (2018)	STM (Science, Technology, Mathematics) learning model	Significant improvement in environmental care attitudes and academic understanding
11	Nurjanah et al. (2024)	Integration of local potential in digital science learning media	Positive impact on learning outcomes, science process skills, and environmental care attitudes
12	Frentika et al. (2016)	Contextual learning based on local potential	Increased environmental awareness regardless of students' initial math abilities
13	Nawawi et al. (2018)	Environmental care character development program	Significant increase in environmental care attitudes and positive community impact
14	Rozhana et al. (2019)	Local potential-based module in Trenggalek region	Effective in fostering environmental care attitudes in elementary students
15	Mutmainnah et al. (2016)	Local potential based modules	Effective in improvingconceptual understanding and environmental care attitudes
16	Suci Utami & Insih Wilujeng (2018)	Student worksheets (LKPD) based on local potential	Effective in increasing concept understanding but less effective in improving environmental care attitudes
17	Restu Prabawati Kurnia & I Gusti Putu Suryadarma (2016)	Utilization of natural resources and ecotourism as learning media	Effective learning tools to hone science skills and enhance environmental awareness and concern
18	Maulida Rahmi et al. (2023)	Teaching materials integrating local potential	Effective in enhancing critical thinking skills and environmental care attitudes

The thematic categorization of the educational approaches identified in the reviewed studies is presented in Appendix C. Based on Table 1 above, the integration of local potential with innovative learning methods has emerged as a transformative approach in environmental education, enhancing students' engagement and environmental awareness. The reviewed studies highlight several educational strategies that leverage local context to foster a deeper understanding of environmental issues and promote sustainable behavior. These methods not only enrich students' learning experiences but also emphasize the importance of environmental care in their immediate

surroundings. One of the key strategies in this approach is context-based learning. By incorporating local environmental issues and practices into the curriculum, students can connect the concepts they are learning to their own experiences and communities. The integration of local knowledge into teaching materials helps make learning more relatable, thus increasing the likelihood that students will internalize and act on the lessons taught.

Project-Based Learning (PjBL) and STEM (Science, Technology, Engineering, and Mathematics) are also highly effective when combined with local potential. Woro Sumarni (2023) exemplified how integrating ethnosciences into PBL and STEM can significantly improve students' critical thinking and problem-solving skills. By working on projects that address local environmental challenges, students not only deepen their understanding of environmental issues but also learn to apply local knowledge in practical ways. This fosters a sense of responsibility and empowers students to contribute solutions to their communities' environmental problems. Moreover, digital teaching tools grounded in local environmental knowledge offer another powerful means of integrating local potential. Suryaningsih (2018) found that ecotourism-related learning experiences significantly enhanced students' environmental care attitudes. These hands-on, real-world learning experiences allow students to directly interact with nature, thereby deepening their understanding of environmental issues. Engaging students in activities that involve direct interaction with the environment helps them form a personal connection to nature, which is crucial for fostering long-term environmental responsibility.

The integration of local wisdom into educational approaches is another vital aspect of this strategy. Studies like those by Suci Utami and Insih Wilujeng (2018) and Kahar et al. (2018) show that when local environmental knowledge and cultural practices are embedded in the learning process, students develop a deeper respect for both their natural and cultural heritage. This localized approach not only enhances students' environmental awareness but also encourages them to see the value in their community's traditional knowledge, which has often been passed down through generations. By including these local insights in educational curricula, students are empowered to become stewards of their local environment, using the knowledge they've gained to advocate for sustainable practices within their own communities.

Impact on Environmental Awareness and Care Attitudes

The impact of educational approaches on environmental awareness and care attitudes has been widely studied, revealing the significant role of effective teaching methods in fostering a sense of environmental responsibility among students. Several studies have categorized the effectiveness of various educational models, with some showing high success rates in improving environmental care attitudes. For instance, the STM learning model has demonstrated remarkable effectiveness in enhancing environmental awareness, with Nawawi et al. (2018) reporting a 100% improvement and Gunawan R.D. (2018) achieving a 95% effectiveness rate. These findings highlight the potential of targeted educational approaches in producing substantial positive changes in students' attitudes toward the environment. However, not all educational strategies have yielded equally strong results. Some studies have shown more moderate improvements, suggesting that the local context and how educational methods are implemented can influence outcomes. For example, Suci Utami and Insih Wilujeng (2018) observed a roughly 50% improvement in the effectiveness of local potential-based learning approaches in Kebumen. This suggests that regional factors, including the specific educational settings and the fidelity with which programs are implemented, play a critical role in determining the success of these interventions. These variations in effectiveness underscore the need for adaptable educational strategies that better suit the specific needs and circumstances of different communities. Moreover, many studies have confirmed the high effectiveness of locally-based educational approaches that integrate local wisdom and contextual content. Maulida Rahmi, Siti Nurhidayati, and Taufik Samsuri (2023), as well as Marlina et al. (2018), found significant improvements in environmental care attitudes when students engaged in learning experiences that reflected local environmental issues and cultural practices. Such contextualized learning has been

shown to deepen students' connection to environmental problems, fostering not only greater awareness but also a stronger commitment to environmental stewardship. These findings underscore the importance of designing educational programs that reflect the local environmental and cultural context, as these elements can enhance the relevance and impact of the learning experience.

Additionally, experiential learning activities, such as ecotourism or field-based environmental studies, have proven particularly effective in increasing students' attitudes toward environmental care. Suryaningsih (2018) found that ecotourism-related activities significantly raised students' concern for the environment, demonstrating that hands-on, nature-connected learning experiences are valuable tools for deepening environmental awareness. This is further supported by research by Erdem and Kaya (2023), who found that integrating local environmental issues into project-based science learning increased students' sense of responsibility and pro-environmental behaviors. These studies highlight the importance of connecting learning content to real-world environmental challenges, which not only enhances student engagement but also encourages meaningful behavioral changes.

Integration of Local Potential in Learning

The integration of local potential in education plays a crucial role in enriching the learning experience and fostering a deeper connection between students and their local communities. Local potential refers to the unique resources an area possesses, including local wisdom, natural advantages, and community culture. By incorporating these resources into various aspects of education, students are not only exposed to content directly relevant to their environment but also gain valuable insights into their cultural heritage and the local ecosystem. This approach has significant implications for improving educational outcomes, environmental awareness, and the development of critical skills among learners. The use of local potential in education has been shown to positively affect learning. Integrating local wisdom and natural resources into teaching materials enhances students' critical thinking and increases their environmental care attitudes. Research by Maulida Rahmi, Siti Nurhidayati, and Taufik Samsuri (2023) demonstrated that incorporating local knowledge effectively boosted pupils' critical thinking skills and their sense of responsibility toward environmental issues. Similarly, the work of Restu Prabawati Kurnia and I Gusti Putu Suryadarma (2016) showed that using natural resources and ecosystems as teaching tools not only improved students' scientific skills but also heightened their environmental concern, indicating that hands-on experiences with local resources are particularly valuable in fostering a deeper understanding of environmental issues.

Further studies have corroborated the effectiveness of local potential in enhancing both environmental attitudes and academic performance. For instance, teaching activities grounded in the local context in Klaten Regency led to significant improvements in students' conceptual understanding and environmental attitudes (Suci Utami & Insih Wilujeng, 2018). This is supported by other research that highlights the success of modules designed around local potential, which have been shown to increase students' understanding of environmental issues while cultivating a stronger sense of environmental responsibility (Mutmainnah et al., 2016; Rozhana et al., 2019). The integration of local potential into science and biotechnology education has also been shown to enhance science process skills, motivation, and practical competencies, thereby contributing to improved learning outcomes (Nurjanah et al., 2024; Dwika et al., 2024; Sriyati et al., 2021; Kahar et al., 2018).

Incorporating local potential into innovative teaching methods not only increases student engagement but also enriches their learning experiences. Studies have shown that resource- and culture-rich local environments promote creativity and innovation, particularly in language learning (Rahmi et al., 2022). The integration of environmental care into character education, as demonstrated by Munawaroh et al. (2022), also instills values of environmental responsibility. These findings are consistent with those of Yildirim and Aydin (2021), who emphasized the role of interdisciplinary approaches in strengthening environmental ethics in science education. Moreover, the adoption of innovative teaching practices has been identified as a key factor in enhancing learning. Educators who

skillfully integrate local knowledge into their teaching can significantly improve the educational experience, as evidenced by research conducted by Novita (2022). The inclusion of environmental education within the curriculum, especially at the primary school level, is essential for nurturing environmentally conscious individuals (Nugroho, 2022). Educational materials focused on population education and environmental issues further support the development of environmentally responsible behaviors (Khoiri & Peterianus, 2021).

Impact on Environmental Care Attitudes

The integration of local potential in education has proven to be a powerful approach in fostering environmental care attitudes among students. By incorporating local wisdom, natural resources, and regional potential into the learning process, this method not only enhances students' understanding of their immediate environment but also encourages active participation in environmental conservation efforts. Through this approach, students can connect more deeply with their surroundings and develop a sense of responsibility for their local ecosystems. One of the significant impacts of this integration is the improvement in students' environmental awareness. Educational modules based on local potential have been shown to effectively improve both students' conceptual understanding of environmental issues and their attitudes toward environmental care. These modules provide a contextually relevant learning experience that resonates with students, making the learning process more meaningful and engaging. Research has demonstrated that when students are exposed to environmental content that is closely tied to their local context, they develop a stronger connection to the environment and a greater sense of responsibility for its preservation. Outdoor and experiential learning activities also play a crucial role in enhancing environmental care attitudes. These hands-on experiences, which often involve direct interaction with nature, help students better understand ecological systems and the importance of environmental stewardship. Activities like those described by Hastutiningsih et al. (2016) have shown that when students are actively involved in the learning process, their awareness of environmental issues deepens, and they are more likely to adopt sustainable behaviors. Such activities not only increase knowledge but also strengthen students' emotional and personal connection to the environment.

Character education programs that focus on environmental care, such as the Adiwiyata program, have also been highly effective in promoting responsible environmental behaviors. These programs, which are often implemented in schools, teach students the values of environmental responsibility and conservation from an early age. Research by Azizah et al. (2020), Gunawan (2018), and Hermawan and Mahmudah (2023) highlights the positive impact of these initiatives in shaping students' attitudes and behaviors toward the environment. By incorporating environmental care into character development, these programs instill a sense of duty to protect the planet and its resources. Engaging students with local wisdom through practical activities further enhances their environmental awareness. Studies by Suryaningsih (2018), Sriyati et al. (2021), and Kahar et al. (2018) demonstrate that when students are involved in learning that incorporates local knowledge and traditional practices, they are more motivated to protect their surroundings. These experiences help students understand the importance of sustainable practices rooted in their own cultural heritage, making the concept of environmental conservation more tangible and relevant to their lives.

A strong relationship exists between environmental knowledge and care attitudes, reinforcing the importance of integrating relevant, context-based content in education. By providing students with knowledge that is both locally grounded and scientifically sound, they are better equipped to understand the complexities of environmental issues and take informed action to address them. This is supported by studies such as those by Woro Sumarni (2023), which emphasize that contextual learning significantly enhances students' understanding and attitudes toward environmental care. In addition to fostering environmental awareness, character development programs that focus on activities like planting trees and biodiversity conservation have proven to cultivate a sense of responsibility and positive behavior toward the environment. These programs help students

understand the importance of protecting biodiversity and the role they can play in conservation efforts. By engaging in such activities, students learn the value of environmental sustainability and become active participants in preserving the natural world for future generations.

Innovative Learning

Innovative learning methods have become a central focus in modern education, particularly in environmental education. These approaches aim to foster deeper engagement, critical thinking, and a stronger connection to sustainability issues. One such method that has gained attention is Project-Based Learning (PjBL), which has been shown to significantly improve students' critical thinking skills, motivation, and environmental care attitudes. By focusing on real-world projects, students can engage with environmental issues in a meaningful and practical way. Research by Maulida Rahmi, Siti Nurhidayati, and Taufik Samsuri (2023) has highlighted that integrating local potential through PjBL enhances not only critical thinking but also students' sense of environmental responsibility. This method encourages students to approach environmental problems with creativity and problem-solving skills, fostering a more engaged and proactive attitude toward sustainability. In addition to PjBL, other innovative methods, such as collaborative learning, have also demonstrated significant benefits in environmental education. Studies by Sukmawati et al. (2019) show that when PjBL is combined with collaborative learning, students achieve better learning outcomes and enhance essential 21st-century skills such as creativity, collaboration, communication, and problem-solving. These skills are crucial in tackling complex environmental challenges, and collaborative learning encourages students to work together to find solutions, fostering a sense of community and shared responsibility toward environmental conservation.

The integration of STEM (Science, Technology, Engineering, and Mathematics) with local cultural knowledge, through approaches like Ethno-STEM, further enriches environmental education. Fathia (2021) emphasized the importance of incorporating local cultural contexts into STEM learning, as it deepens students' understanding and makes the learning experience more relevant. By connecting scientific knowledge with local wisdom and regional potential, students can see the direct application of their learning in their communities, which enhances their engagement with environmental topics. Sudarmin et al. (2023) demonstrated that Ethno-STEM-based project learning, particularly in chemistry, not only improves students' conservation skills but also fosters entrepreneurial character, preparing them for future challenges in environmental sustainability. Moreover, Usta and Atalay (2022) highlighted the relevance of local cultural practices in science education, noting that these practices can make scientific knowledge more meaningful to students. However, it is important that this local knowledge aligns with scientific principles to avoid misconceptions. When used correctly, this integration of local cultural practices helps cultivate students' environmental responsibility while also equipping them with critical skills needed for the Fourth Industrial Revolution, such as technological literacy, innovation, and collaboration. Ethno-STEM thus offers a compelling approach to environmental education that is both relevant and impactful, fostering a generation that values sustainability and conservation. Collaborative and problem-based learning methods, which focus on active participation, are also key components of innovative learning in environmental education. These methods encourage students to engage deeply with environmental challenges, collaborate effectively with peers, and develop solutions that support long-term ecological balance. By working on real-world environmental problems, students develop practical skills while learning to value sustainable practices they can apply in their communities and beyond.

Integration of Digital Teaching Materials in Environmental Education

The integration of digital teaching materials in environmental education has proven to be a transformative approach that enhances both the learning experience and students' attitudes toward

environmental care. Digital resources, such as multimedia tools, e-books, and online platforms, offer a dynamic way to engage students with environmental issues, making education more accessible, interactive, and flexible. The use of these digital materials has been shown to significantly improve students' environmental knowledge and promote a stronger sense of responsibility toward the environment. Research has demonstrated that incorporating local potential into digital teaching materials can have a substantial impact on learning outcomes. For instance, studies have found that integrating local knowledge and context into digital science learning materials enhances students' science process skills and fosters a more positive attitude toward environmental care. By connecting students to their immediate surroundings through digital tools, the learning experience becomes more relevant and relatable, helping students to better understand the environmental challenges they face in their own communities.

Further evidence highlights the importance of digital resources in the development of students' character, particularly regarding environmental care. Research on I-SETS-based digital teaching materials has shown that these resources contribute to character development, encouraging students to adopt more sustainable behaviors and become more aware of the environmental issues affecting their world. The interactive nature of digital materials, including videos, animations, and simulations, provides a more engaging learning experience that encourages active participation and a deeper understanding of environmental topics. The relationship between knowledge gained from digital materials and the formation of environmental care attitudes is also well established. Studies have shown that digital resources significantly increase students' environmental knowledge, leading to greater concern for environmental issues. This supports the effectiveness of multimedia-enhanced learning environments, which make education not only more engaging but also more effective in fostering a genuine interest in environmental sustainability.

Digital teaching materials also offer significant advantages in terms of accessibility and flexibility, particularly for remote or flexible learning environments. Information and communication technology (ICT) has enabled teachers to create and distribute digital teaching materials that students can access at any time and from anywhere. This flexibility enriches the learning experience by allowing students to learn at their own pace and revisit content as needed. Applications such as KVSoft Flipbook and AnyFlip Web enable teachers to create interactive digital content that enhances students' engagement with the material, making learning more personalized and effective.

Moreover, digital resources like e-encyclopedias have been found to stimulate active participation among students, particularly in the context of local biodiversity conservation. Studies have shown that digital materials focused on local biodiversity, when combined with multimedia features, can increase students' awareness of the importance of preserving their natural surroundings. By using digital tools to explore biodiversity in an engaging and interactive way, students are more likely to develop sustainable attitudes toward conservation.

Discussion

The results of this systematic literature review indicate that integrating local potential with innovative pedagogical approaches plays a significant role in strengthening environmental education and promoting students' attitudes toward environmental care. The reviewed studies consistently demonstrate that contextual learning environments that incorporate local knowledge, environmental resources, and community-based experiences enhance both cognitive understanding and affective engagement with environmental issues. These findings support the growing consensus in environmental education research that meaningful learning occurs when scientific knowledge is situated within learners' sociocultural and ecological contexts.

One of the most prominent patterns identified in this review is the effectiveness of contextual and locally grounded learning in improving environmental awareness. Teaching materials and learning activities that integrate local environmental issues help students connect theoretical concepts to real-world environmental challenges in their communities**.** Several studies included in this review

consistently indicate that contextualized instructional materials enhance environmental knowledge and foster pro-environmental attitudes (Marlina et al., 2015). These findings are consistent with constructivist learning theory, which suggests that knowledge construction is strongly influenced by prior experiences and meaningful contexts. When environmental education is linked to students' immediate surroundings, learners are more likely to develop a deeper understanding of ecological relationships and recognize their personal responsibility in environmental conservation.

Another important finding concerns the role of innovative pedagogical models, particularly Project-Based Learning (PjBL), STEM-based learning, and Ethno-STEM approaches. These instructional strategies emphasize inquiry, collaboration, and problem-solving, which are essential competencies for addressing complex environmental challenges. The study by Woro Sumarni (2023) demonstrates that integrating ethnoscience into STEM-oriented project-based learning significantly improves students' critical thinking, creativity, collaboration, and communication skills while also strengthening conservation-oriented character. From a pedagogical perspective, such approaches align with contemporary educational frameworks that advocate for active and problem-oriented learning environments. By engaging students in projects that address authentic environmental problems, these models facilitate the application of scientific knowledge to practical contexts and encourage learners to develop solutions relevant to their communities.

Experiential learning also emerges as a critical factor in shaping students' environmental awareness and attitudes. Educational experiences involving outdoor learning, field-based investigations, and ecotourism activities provide opportunities for students to interact directly with natural environments. Suryaningsih (2018) reported that ecotourism-based learning significantly increased students' environmental concern and ecological awareness. These results are supported by experiential learning theory, which emphasizes that knowledge is more effectively internalized when learners actively engage in concrete experiences and reflective processes. Direct engagement with natural ecosystems enables students to observe ecological processes firsthand and fosters emotional connections with the environment, which are essential for the development of long-term environmental responsibility.

The integration of local wisdom into environmental education is also a key element of effective learning strategies. Traditional ecological knowledge, which has developed through long-term interactions between communities and their environments, provides valuable insights into sustainable resource management and environmental stewardship. Studies by Suci Utami and Insih Wilujeng (2018) and Kahar et al. (2018) indicate that incorporating local cultural knowledge into science learning enhances students' appreciation for both environmental sustainability and cultural heritage. From a socio-cultural perspective, learning is inherently embedded within cultural contexts; therefore, integrating local wisdom into environmental education not only enriches the learning process but also strengthens students' environmental ethics and sense of place.

Despite the overall positive impacts identified in the literature, this review also reveals variations in the effectiveness of different instructional approaches. While several studies report substantial improvements in environmental care attitudes, others demonstrate more moderate outcomes. These variations suggest that the effectiveness of locally integrated environmental education depends on multiple contextual factors, including the quality of instructional design, teachers' pedagogical competencies, institutional support, and the extent to which learning activities engage students in meaningful environmental action. In some cases, integrating local potential into teaching materials improves conceptual understanding but does not necessarily translate into behavioral change. This suggests that knowledge acquisition alone may be insufficient to cultivate sustainable environmental behavior, underscoring the importance of integrating cognitive, affective, and experiential learning components in environmental education.

Another emerging trend identified in the reviewed literature is the increasing use of digital teaching materials to support environmental learning. Digital resources such as multimedia modules, interactive platforms, and online learning tools enable educators to integrate local environmental content with modern technological approaches. Studies included in this review suggest that digital

teaching materials based on local potential can enhance students' science process skills, environmental literacy, and attitudes toward environmental care. The interactive nature of digital learning environments, which often includes simulations, visualizations, and multimedia content, provides engaging opportunities for students to explore environmental concepts. In addition, digital resources offer greater accessibility and flexibility, enabling learners to access environmental knowledge beyond the traditional classroom setting.

Although the reviewed studies demonstrate the potential of integrating local potential in environmental education, several research gaps remain. First, most existing studies focus primarily on short-term educational outcomes, such as improvements in knowledge, attitudes, or motivation to learn. Limited research has examined the long-term impact of these educational interventions on students' environmental behaviors and sustainable lifestyles. Future studies should therefore investigate whether locally integrated environmental education can produce lasting behavioral changes beyond the classroom context.

Second, many studies explore individual instructional strategies in isolation, such as PjBL, contextual learning, or digital-based instruction. However, limited research has examined how these approaches can be systematically integrated into comprehensive environmental education frameworks. A more holistic pedagogical model that combines contextual learning, experiential activities, digital resources, and character education may provide more effective outcomes in fostering environmental responsibility.

Third, although local wisdom is widely recognized as a valuable educational resource, further research is needed to ensure that the integration of traditional knowledge aligns with scientific principles and avoids potential misconceptions. Developing frameworks that effectively bridge indigenous knowledge systems with scientific perspectives remains an important challenge in environmental education research.

Finally, most of the studies reviewed in this research are conducted within specific local contexts, which limits the generalizability of their findings. Comparative studies across different cultural, geographical, and educational contexts are necessary to better understand how local potential can be adapted and implemented in diverse educational settings.

Overall, the findings of this review highlight that integrating local potential with innovative pedagogical approaches offers a promising pathway to strengthen environmental education. Such integration not only enhances students' environmental knowledge but also fosters the development of environmental values, attitudes, and responsible behaviors. By connecting scientific learning to local ecological contexts and cultural practices, education can play a vital role in cultivating environmentally literate citizens capable of contributing to sustainable development in their communities.

Conclusion and Implications

This systematic literature review highlights the significant role of integrating local potential with innovative learning approaches in strengthening environmental education and fostering students' attitudes toward environmental care. The synthesis of the reviewed studies indicates that learning strategies that incorporate local environmental contexts, cultural knowledge, and community resources can enhance both cognitive understanding and affective engagement with environmental issues. By connecting scientific concepts to students' everyday experiences and local ecological challenges, contextualized learning environments enable learners to develop a deeper awareness of environmental problems and a stronger sense of responsibility toward environmental sustainability.

The findings further demonstrate that innovative pedagogical approaches such as Project-Based Learning (PjBL), STEM-based learning, contextual learning, and experiential learning activities provide effective pathways for integrating local potential into environmental education. These approaches encourage active participation, critical thinking, collaboration, and problem-solving while allowing students to apply scientific knowledge to real environmental issues within their

communities. Experiential learning activities, including outdoor learning and field-based environmental exploration, also contribute significantly to the development of environmental awareness by enabling students to directly observe and interact with natural ecosystems.

Another important conclusion emerging from this review is the relevance of integrating local wisdom and cultural knowledge into environmental education. Traditional ecological knowledge represents a valuable educational resource that can enrich scientific learning while simultaneously strengthening students' cultural identity and environmental ethics. When educational programs incorporate local wisdom alongside scientific perspectives, students are better able to understand sustainable environmental practices that are rooted in their communities' cultural heritage. This integration not only enhances environmental awareness but also supports the preservation of local knowledge systems.

In addition, the increasing use of digital teaching materials presents new opportunities for enhancing environmental education. Digital resources such as multimedia modules, interactive platforms, and online learning environments can effectively combine technological innovation with locally relevant environmental content. The reviewed studies indicate that digital learning materials based on local potential can improve students' environmental knowledge, science process skills, and environmental care attitudes while also increasing accessibility and engagement in the learning process.

From a theoretical perspective, the findings of this review contribute to the growing body of literature emphasizing the importance of contextual and culturally responsive approaches in environmental education. Integrating local potential with innovative pedagogical strategies aligns with constructivist and sociocultural learning theories, which emphasize the role of context, experience, and cultural interaction in knowledge construction. The review also highlights the need for interdisciplinary learning frameworks that combine scientific knowledge, cultural perspectives, and real-world environmental challenges.

From a practical perspective, the results of this study provide important implications for educators, curriculum developers, and policymakers. Teachers are encouraged to design learning experiences that incorporate local environmental issues, community knowledge, and experiential activities to make environmental education more meaningful and relevant to students. Curriculum developers should consider integrating local potential and environmental themes into science and environmental education curricula to strengthen contextual learning. Furthermore, educational policymakers may support the development of locally based environmental education programs and provide resources that facilitate the integration of digital technologies and community-based learning.

Despite these contributions, this review also identifies several directions for future research. Further studies are needed to examine the long-term impact of locally integrated environmental education on students' environmental behaviors and sustainable lifestyles. In addition, future research should explore the development of comprehensive learning models that combine contextual learning, innovative pedagogies, digital resources, and local wisdom within a unified environmental education framework. Comparative studies across different cultural and educational contexts would also provide valuable insights into how local potential can be effectively integrated into environmental education in diverse settings.

Overall, integrating local potential with innovative learning approaches offers a promising pathway to strengthen environmental education and promote environmentally responsible behavior among students. By connecting scientific knowledge with local ecological realities and cultural practices, education can play a crucial role in cultivating environmentally literate individuals capable of contributing to sustainable development in their communities.

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Appendix

This appendix provides supplementary information supporting the systematic literature review presented in this study. The materials included here describe the article selection process and the detailed characteristics of the reviewed studies. These additional data enhance the transparency and reproducibility of the review by presenting the search strategy, screening stages, and the complete matrix of the selected articles.

Appendix A

Article Selection Process

The literature included in this study was identified through a systematic search of relevant databases and scholarly sources. The search process focused on studies examining the integration of local potential or local wisdom with innovative learning approaches in environmental or science

education. Keywords used in the search included combinations of *local potential*, *local wisdom*, *environmental education*, *innovative learning*, *STEM learning*, *project-based learning*, and *environmental awareness*.

The selection process involved several stages, including identification, screening, eligibility assessment, and final inclusion of relevant articles. Studies were included if they met the following criteria: (1) they discussed the integration of local potential or local wisdom in educational practices; (2) they examined innovative learning approaches such as project-based learning, STEM-based learning, contextual learning, experiential learning, or digital learning; and (3) they reported educational outcomes related to environmental awareness, environmental attitudes, or related competencies. Articles that did not focus on educational contexts or did not provide empirical or conceptual evidence relevant to environmental education were excluded.

The article screening process yielded a final selection of 19 studies that met the inclusion criteria and were analyzed in this review.

Table A1

Article screening and selection process

Stage of Review	Description	Number of Articles
Initial identification	Articles retrieved from database searches and reference lists	76
Screening	Articles screened based on title and abstract relevance	50
Eligibility	Full-text articles assessed for eligibility	25
Final inclusion	Articles meeting all inclusion criteria	18

Appendix B

Characteristics of Reviewed Studies

This appendix presents a detailed matrix of the studies included in the systematic literature review. The table summarizes the authors, publication year, educational approaches, and the major outcomes reported in each study. The purpose of this matrix is to provide a comprehensive overview of how local potential has been integrated with innovative learning methods in environmental education.

Table B1

Matrix of reviewed studies on the integration of local potential and innovative learning

No	Author(s)	Year	Educational Approach	Main Educational Outcomes
1	Woro Sumarni	2023	Integration of ethnoscience in STEM and Project-Based Learning	Improvement of 4C skills, development of conservation character, and application of local knowledge in problem solving
2	Marlina et al.	2015	Environmental knowledge module based on local context	Improved environmental awareness and care attitudes
3	Kahar et al.	2018	Biology learning tools	Improved conceptual

No	Author(s)	Year	Educational Approach	Main Educational Outcomes
			based on local potential and environmental literacy	understanding and conservation attitudes
4	Sriyati et al.	2021	Biotechnology learning tools based on local potential	Improved theoretical knowledge, practical skills, and appreciation of local culture
5	Suryaningsih	2018	Ecotourism activities as experiential learning	Increased environmental concern through direct environmental interaction
6	Dwika et al.	2024	Integration of local potential in biotechnology learning	Improved learning quality and student motivation
7	Bakhtiar	2016	Teaching materials based on local wisdom and STEM	Increased student learning outcomes and engagement
8	Azizah et al.	2020	I-SETS-based teaching materials	Development of environmental care character and curiosity
9	Hastutiningsih et al.	2016	Outdoor learning guide based on experiential learning	Development of environmental awareness and ecological understanding
10	Gunawan R.D.	2018	STM (Science, Technology, and Mathematics) learning model	Significant improvement in environmental care attitudes
11	Nurjanah et al.	2024	Digital science learning media based on local potential	Improved science process skills and environmental care attitudes
12	Frentika et al.	2016	Contextual learning based on local potential	Increased environmental awareness regardless of students' academic background
13	Nawawi et al.	2018	Environmental care character development program	Significant improvement in environmental responsibility
14	Rozhana et al.	2019	Local potential-based module	Effective in fostering environmental care attitudes among elementary students
15	Mutmainnah et al.	2016	Local potential-based learning module	Improved conceptual understanding and environmental attitudes
16	Suci Utami & Insih Wilujeng	2018	Student worksheets (LKPD) based on local potential	Improved conceptual understanding with moderate improvement in environmental attitudes
17	Restu Prabawati Kurnia & I Gusti Putu Suryadarma	2016	Utilization of natural resources and ecotourism as learning media	Improved science skills and environmental awareness
18	Maulida Rahmi et al.	2023	Teaching materials integrating local potential	Improved critical thinking skills and environmental care attitudes

Appendix C

Categorization of Educational Approaches

To better understand the trends in the reviewed literature, the educational approaches identified in the selected studies were categorized into several major groups. These categories illustrate the dominant pedagogical strategies used to integrate local potential into environmental education.

Table C1

Categories of educational approaches identified in the reviewed studies

Category	Educational Approach	Number of Studies
Contextual learning	Modules, teaching materials, and worksheets based on local context	6
Innovative learning models	Project-Based Learning, STEM, Ethno-STEM, STM	5
Experiential learning	Outdoor learning, ecotourism, environmental field activities	2
Digital learning	Digital teaching materials and multimedia learning tools	2
Character education programs	Environmental care character development programs	3

The categorization presented in Table C1 illustrates that contextual learning and innovative pedagogical models are the most frequently used approaches for integrating local potential in environmental education. This trend highlights the increasing emphasis on connecting scientific learning with local environmental contexts and real-world experiences in order to strengthen students' environmental awareness and sustainability attitudes.