JPPIPA 11(6) (2025)

Jurnal Penelitian Pendidikan IPA

http://jppipa.unram.ac.id/index.php/jppipa/index

Integration of Ethnoscience in Natural Science learning: Literacy Study

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Received: December 10, 2024
Revised: May 23, 2025
Accepted: June 25, 2025
Published: June 30, 2025

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DOI: 10.29303/jppipa.v11i6.9980

Abstract: Science education is essential for developing scientific literacy and critical thinking. However, traditional approaches often lack contextual relevance, especially in areas rich in local wisdom. This study aims to examine how ethnoscience—science learning that integrates local cultural values—can enhance meaningful learning while preserving cultural identity. The objective is to analyze its application, identify potential local cultural topics, and evaluate effective teaching methods. This qualitative research is conducted through a literature review following the PRISMA framework. From 98 articles identified via the Scopus database, 27 were selected for in-depth analysis. Data were analyzed using thematic content analysis. Results show that 55.56% of the studies used interdisciplinary approaches, while Biology topics were underrepresented (7.40%). Physics and Chemistry showed high contextual relevance, particularly in traditional technologies and natural materials. Common local cultural themes include crafts, martial arts, measurement tools, games, traditional medicine, and eco-friendly pesticides. Media used include modules, digital worksheets, LMS, and interactive technology. Effective pedagogical models include Ethno-STEM, EthCBL, RE-STEM, E-PjBL, and SIL, all of which promote scientific literacy, 21st-century competencies, and cultural appreciation. The findings highlight the potential of ethnoscience to support holistic and culturally responsive science education.

Keywords: Cultural integration; Ethnoscience; Learning theory and practice; Local wisdom; Science learning

Introduction

Science education plays an important role in shaping students' understanding of the natural world while developing critical thinking skills and scientific literacy that are much needed in modern society. However, science learning approaches that often use conventional methods are considered less relevant to the context of students' daily lives, especially for those who live in areas with rich local wisdom. Science learning that is not relevant to students' culture and experiences can result in low student engagement and understanding of the material being taught. Students may feel that science is something that is far from their daily lives, so that their motivation and interest in learning decrease (Hafsa, 2022; Adedoyin & Belo, 2021). To increase the relevance of learning, an approach is needed that combines science with the local context so that students can see the value of science in their lives and are more motivated to understand the scientific concepts being learned.

Integration of ethnoscience and local tradition-based and cultural science in Natural Science (IPA) learning has been identified as a potential approach to address this relevance challenge. Through ethnoscience, students are introduced to scientific concepts through local values and practices that they are already familiar with and experience in their daily lives (Rahmawati & Ridwan, 2023). For example, science learning can be aligned with local agricultural traditions, traditional

How to Cite:
Sudirman, S., Sutikno, S., Indriyanti, D. R., Sumarni, W., & Rahayuningsi, M. (2025). Integration of Ethnoscience in Natural Science learning: Literacy Study. *Jurnal Penelitian Pendidikan IPA*, *11*(6), 68–77. https://doi.org/10.29303/jppipa.v11i6.9980

medicines, or crafts that reflect scientific principles. By connecting modern scientific knowledge with cultural experiences, students are expected to be able to understand scientific concepts more deeply, not only as theoretical knowledge but also as knowledge that can be applied critically and reflectively in their daily lives (Aikenhead & Michell, 2011; Lee, 2020).

Scientific literacy itself is the ability to understand, use, and interpret scientific knowledge in order to address real-world challenges (OECD, 2018). By introducing local aspects through ethnoscience, it is hoped that students can develop more contextual scientific literacy. This means that students are not only able to understand scientific theory but also apply scientific literacy skills in cultural contexts that are relevant to their lives. Ethnoscience-based learning also helps students build a strong cultural identity, appreciate cultural diversity, and understand the relationship between culture and science as part of the learning ecosystem. This encourages them to interpret science as part of life, not just a lesson that needs to be memorized in class (Kim & Roth, 2021).

On the other hand, the success of ethnoscience integration in science learning requires a deep understanding of relevant ethnoscience concepts, topics that can be integrated into science materials, and effective learning theories and practices. It is important to explore how ethnoscience can be applied in science learning, both in Biology, Physics, and Chemistry subjects. This study should also include the identification of ethnoscience topics that are in accordance with curriculum needs and relevant to students' lives. In addition, learning theories and practices that support ethnoscience integration, such as the use of appropriate learning tools, models, and methods, need to be evaluated to ensure their effectiveness in improving students' understanding of science.

The purpose of this study is to analyze the application of ethnoscience in science learning (Biology, Physics, and Chemistry) in order to understand how local cultural concepts can enrich students' understanding of science. This study also aims to identify relevant ethnoscience topics in science learning so that it can determine the appropriate local cultural materials or concepts to be integrated into the science curriculum. In addition, this study seeks to evaluate the theory and practice of science learning related to ethnoscience, including learning tools, approaches, models, and methods, to assess the effectiveness of integrating cultural values in science teaching. Thus, this study is expected to contribute to the development of more holistic and contextual local culture-based science learning.

Ethnoscience has the potential to enrich science learning by contextualizing scientific concepts within local cultural practices. However, the relationship between ethnoscience and specific science disciplines such as Biology, Physics, and Chemistry remains underexplored. It is also important to understand how various ethnoscience topics can be integrated meaningfully into science curricula. Furthermore, there is a need to examine how science learning tools and methods support the integration of ethnoscience in classroom settings.

This study aims to analyze the application of ethnoscience in science education, identify relevant local cultural topics, and evaluate teaching methods that support such integration.

Method

The integration of ethnoscience in Natural Science learning is carried out through qualitative research based on literature review. The systematic review process follows a modified procedure that adopts the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) method, which includes four main stages: identification, screening, eligibility, and inclusion (Widarti et al., 2025). The PRISMA flowchart for this systematic review can be seen in Figure 1.

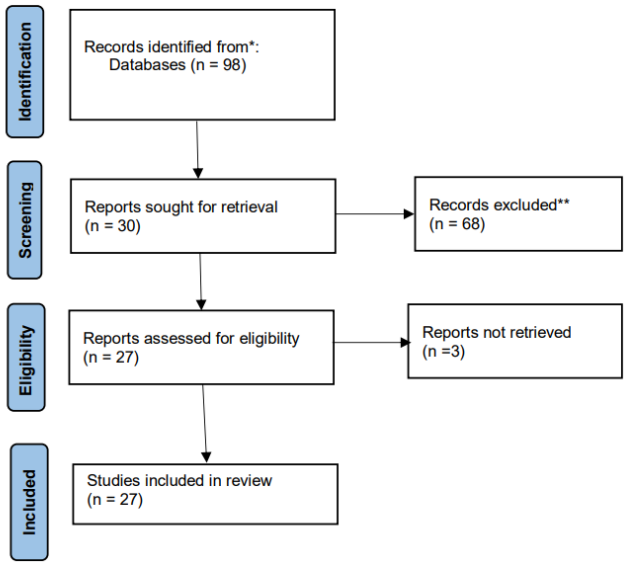

Figure 1. PRISMA flowchart

The first stage in this study was the identification of related literature, which began by searching for scientific research articles in the Scopus academic database using the keyword "ethnoscience and learning" applied to the title, abstract, and keywords, resulting in 98 article documents. This search was then filtered with additional criteria, namely the year of publication between 2016 and 2024, the type of article document, in English, and

open access, so that 30 articles were obtained that met the initial criteria, while 68 other articles were discarded. Furthermore, a thorough reading of the 30 articles was carried out to ensure relevance to the topic of ethnoscience in learning, and 27 articles were found that met the predetermined inclusion criteria, while 3 other articles were discarded. The inclusion criteria used included articles published in Scopus-indexed international journals, published between 2016-2024, article type, open access, and related to ethnoscience in learning. The next step was to extract and synthesize data from 27 selected articles, focusing on findings related to science subjects (Biology, Physics, and Chemistry), main topics, and learning theories and practices related to ethnoscience. All eligible articles are presented in a table 1 to facilitate further analysis.

Table 1. List of Articles on Ethnoscience Approaches in Science Education

No	Articles
1	Acehnese Ethnoscience As an Interdisciplinary Approach in Physics Education: Innovating in The Era of Merdeka Belajar
2	A Framework for Building Scientific Literacy Through an Inquiry Learning Model Using an Ethnoscience Approach
3	Ethnoscience Learning: How Do Teacher Implementing to Increase Scientific Literacy in Junior High School
4	How Does Ethnoscience-Students' Worksheet (ESW) Influence in Science Learning?
5	Engklek Game Ethnoscience-Based Learning Material (Egeblm) To Improve Students' Conceptual Understanding and Learning Motivation
6	Hybrid Ethno-Project Based Learning Integrated with Virtual Assistive Technology to Enhance Students' Critical Thinking in Fundamental Physics Course
7	E-Learning and Physics Teaching Materials Based on Malay Ethnoscience on The East Coast
8	Indonesian National Assessment Support: Can RE-STEM Android App Improve Students' Scientific Literacy Skills?
9	Dynamic Blend of Ethnoscience and Inquiry in A Digital Learning Platform (E-Learning) For Empowering Future Science Educators' Critical Thinking
10	Indigenous Science Constructs Based on Troso Woven Fabric Local Wisdom: A Study in Ethnoscience and Ethnoecology
11	The Effect of Ethnoscience-Based Course Review Horay Learning Towards Cultural Concept Understanding and Science Process Skills of The Elementary School Students
12	Chemistry Project-Based Learning for Secondary Metabolite Course with Ethno-Stem Approach to Improve Students' Conservation and Entrepreneurial Character in the 21st Century
13	Exploring Indigenous Knowledge of Traditional Martial Art "Silat Beksi" to Identify Contents and Contexts for Science Learning in Biology Education
14	Inquiry-Creative Learning Integrated with Ethnoscience: Efforts to Encourage Prospective Science Teachers' Critical Thinking in Indonesia
15	Learning About Pesticide Use Adapted erom Ethnoscience as A Contribution to Green and Sustainable Chemistry Education
16	Indonesian Curriculum Reform in Policy and Local Wisdom: Perspectives from Science Education
17	Effect Of Contextual Collaborative Learning Based Ethnoscience to Increase Student's Scientific Literacy Ability
18	The Effect of Ethnoscience-Themed Picture Books Embedded Within Contextbased Learning on Students' Scientific Literacy
19	Reconstruction And Scientific Explanation of Akar Kuning (Arcangelisia Flava Merr.) From West Sumatra as Ethnomedicine and Source of Science Learning
20	The Urgency of Religious and Cultural Science in Stem Education: A Meta Data Analysis
21	Local And Scientific Knowledge in The School Context: Characterization and Content of Published Works
22	A Multi-Perspective Reflection on How Indigenous Knowledge and Related Ideas Can Improve Science Education for Sustainability
23	The Development of PBL-Based Worksheets Integrated with Green Chemistry and Ethnoscience to Improve Students' Thinking Skills
24	Ethnoscience Investigation in Primary Schools: Impact on Science Learning
25	A Needs Assessment of Edutainment Module with Ethnoscience Approach Oriented to The Love of The Country
26	An Ethnoscience Study in Chemistry Learning to Develop Scientific Literacy
27	Science Integrated Learning Model to Enhance the Scientific Work Independence of Student Teacher in Indigenous Knowledge Transformation

Result and Discussion

How is ethnoscience related to science learning (Biology, Physics, and Chemistry)?

Ethnoscience related to science learning is grouped into general science subjects, biology, physics, and chemistry from the number of journals analyzed as many as 27. The following is the distribution of research articles related to ethnoscience in science learning, which are grouped by subject to show the extent to which ethnoscience is applied in each field of science. and the results can be seen in Figure 1.

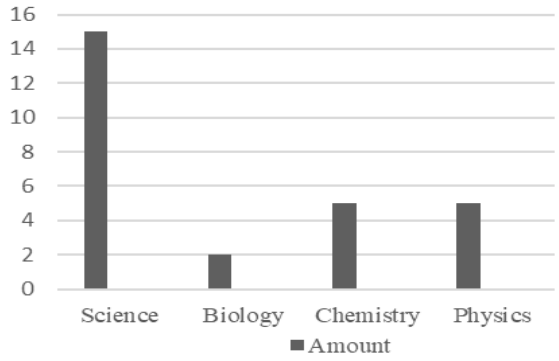

Figure 1. Distribution of Articles Based on Scientific Fields

The data show that research articles related to ethnoscience in education are distributed across several subject areas, including general science, biology, physics, and chemistry. A total of 15 articles (55.56%) discuss the application of ethnoscience in science learning in a general or interdisciplinary context. This proportion suggests that more than half of the studies adopt an integrated approach rather than focusing on a single scientific discipline. Such a tendency reflects the nature of ethnoscience as a holistic framework that facilitates the incorporation of various scientific concepts in a unified and contextually rich manner.

Only 2 articles (7.40%) were found to specifically discuss the application of ethnoscience in biology learning. This relatively low number suggests that research on ethnoscience within the context of biology has not yet received significant attention. One possible reason is the inherent complexity in aligning ethnoscientific perspectives with biological content, which often requires a more tailored and specific approach. Another contributing factor may be the tendency of researchers to focus on broader scientific concepts that are more readily adaptable to ethnoscience frameworks. Ikram et al. (2022) also emphasize that the integration of ethnoscience in biology is still limited when compared to its application in physics or chemistry. To address this gap, it is essential to develop more targeted strategies, such as incorporating traditional ecological knowledge or exploring culturally rooted systems of natural medicine, to make ethnoscience a viable and impactful method in biology education.

Meanwhile, the fields of physics and chemistry each have 5 articles (18.52%) discussing the application of ethnoscience. This percentage shows that the concepts in physics and chemistry have strong relevance to local cultural practices, allowing for easier integration of ethnoscience. In physics, ethnoscience is often applied to traditional technologies or mechanical principles used by local communities (Sumarni, 2018). While in chemistry, ethnoscience includes traditional practices such as the use of natural materials in making dyes or medicines. This relationship shows that both fields can be connected to local cultural practices to support more contextual learning.

Overall, these data reflect that ethnoscience has great potential to enrich science learning by making science concepts more relevant to local cultures. Integrating traditional knowledge into science education not only provides students with a more holistic understanding but also helps them see the connection between modern science and traditional practices. For example, a study by Rahmawati and Ridwan (2017) showed that integrating ethnoscience into science learning can help students understand the connection between modern science concepts and traditional practices. Thus, ethnoscience has great flexibility to be applied in various science disciplines as well as great potential to support more holistic and contextual learning.

How are ethnoscience topics related to science learning?

Ethnoscience topics related to Natural Science learning are grouped as follows: i) if the article does not specifically mention the topic, then it is included in the category "Culture and local wisdom in general"; and ii) if the article specifically mentions a certain topic, then the topic is categorized according to what is stated in the article. The following table shows the number of articles containing ethnoscience topics in various categories, including culture and local wisdom of the community, traditional clothing, martial arts, traditional measuring tools, environmental conservation, traditional toys, natural pesticides, and traditional medicine.

Table 2. Distribution of Ethnoscience Topics

Content	Amount
Culture and local wisdom in general	19
Traditional clothing	1
Traditional martial arts	1
Traditional measuring instruments	1
Environmental conservation	1
Traditional toys	2
Natural pesticides	1
Traditional medicine	1
Total	27

Table 2 presents the distribution of article themes related to ethnoscience-based science learning. The theme “culture and local wisdom of society in general” emerges as the most dominant, appearing in 19 articles. This significant proportion suggests that cultural values and local wisdom possess substantial potential as a foundation for science education. The broad nature of this theme allows it to encompass diverse aspects of life, including social values, traditional practices, and local beliefs that are often passed down across generations

(Fadli & Irwanto, 2020). These elements serve as rich sources for contextualizing scientific concepts and making them more relatable to students.

Research by Wulandari et al. (2021) reinforces this view by highlighting that local culture plays a vital role in strengthening scientific understanding. Through the incorporation of familiar cultural contexts, students are more likely to connect abstract scientific ideas with their daily experiences, thus enhancing both comprehension and engagement in learning. The findings in Table 3 indicate the relevance and feasibility of integrating cultural themes into science curricula as a way to promote meaningful and culturally responsive learning environments.

Other categories, such as "traditional toys," which only appeared in two articles, indicate that interest in traditional toys as a means of science education is still limited. However, traditional toys have unique potential in helping students develop motor skills while understanding simple physics concepts, as shown in a study by Setiawan and Wati (2019). Categories with fewer articles, with one article each, include themes such as "traditional clothing," "traditional martial arts," "traditional measuring tools," "environmental conservation," "natural pesticides," and "traditional medicine." This indicates the need for further research in these areas. According to Sari et al. (2022), although these categories have not been widely explored, they have great potential to be developed as contextual and relevant learning tools for people's lives.

Ethnoscience in science learning covers a variety of topics related to cultural values and local wisdom, such as community cultural knowledge and practices, social diversity, customary values, and the integration of religious knowledge into STEM education. For example, traditional crafts such as Troso woven cloth production demonstrate local expertise in utilizing natural resources. Traditional martial arts, such as Silat Beksi from the Betawi tribe, introduce typical self-defense movements based on culture. Traditional measuring tools, such as the measure for measuring rice in zakat fitrah, demonstrate the relevance of local knowledge in modern life. Environmental conservation efforts are seen in the concept of green chemistry, which emphasizes environmentally friendly processes and products. Traditional games, such as hopscotch, provide motor learning experiences while introducing local culture. Traditional tools, including tarutu, tin telephones, and bird whistles, teach students about simple innovations in society. In agriculture, the production of natural pesticides from local plants reflects efforts to protect plants without the use of hazardous chemicals. In addition, traditional medicines, such as the use of the Yellow Root plant (Arcangelisia flava Merr.), Provide insight into the heritage of local knowledge in utilizing plants for health.

How are Science Learning Tools Related to Ethnoscience?

Learning tools related to ethnoscience are divided into categories: 1) Learning media; and 2) Learning approaches and models.

1) Learning Media Related to Ethnoscience

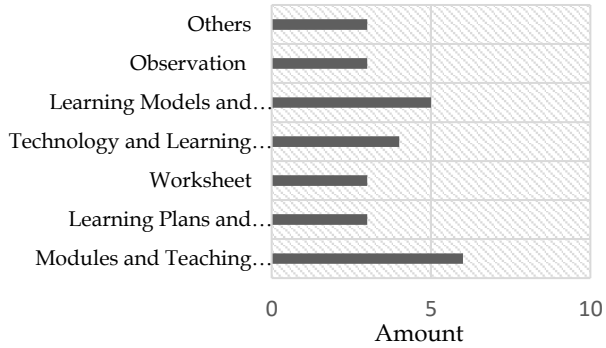

Figure 2. Distribution of Learning Media Categories

The figure 2 above resents the distribution of the use of various categories of learning media, including Modules and Teaching Materials, Learning Plans and Planning, Worksheets, Technology and Learning Media, Learning Models and Methods, Observations, and other categories. This graph illustrates the amount of use for each category, providing an overview of trends or preferences in the use of learning media. Overall, the distribution of learning media by category shows the diversity of types of media used in the educational process, with a total of 27 items. The largest category is *Modules and Teaching Materials*, which includes modules, Lesson Implementation Plans (RPP), *Learning Management System* (LMS)-based teaching materials, and ethnoscience-themed picture story books. This finding emphasizes the importance of developing local culture-based teaching materials, which can enrich students' understanding of content based on traditional values (Yusuf et al., 2022).

The next category is *Learning Plans and Planning*, which consists of three items, namely RPP and semester implementation plans. This shows that comprehensive planning is essential to guide teachers in managing learning effectively (Sanjaya, 2020). Meanwhile, the *Worksheet* category, which includes Student Worksheets (LKM), Student Worksheets (LKPD), and Student Worksheets (LKS), supports students in developing practical skills and critical thinking skills independently (Daryanto, 2019).

The Digital Learning Technology and Platform category includes tools such as Virtual Assistive Technology (VAT), Android-based RE-STEM applications, e-learning platforms, and learning management systems (LMS). These media enhance

student flexibility in accessing instructional content and contribute to increased engagement (Riyanto & Carmeli, 2021). The Learning Models and Methods category comprises five components: project-based models, simple extraction methods, Problem-Based Learning (PBL), science literacy, and Science Integrated Learning (SIL). Each of these approaches is structured to deepen students' comprehension by promoting interactive and contextual learning experiences that bridge theoretical knowledge with real-world applications (Sugiyanto, 2018).

Next, the *Observation and Direct Observation* category highlights the importance of direct observation-based learning, which allows students to understand phenomena in real contexts (Gagne et al., 2005). Finally, the *Others* category, which consists of three items that are not explicitly mentioned, likely includes additional media or methods that remain relevant but have not been classified.

The variety of learning media listed in this table shows their role in supporting the development of students' cognitive, affective, and psychomotor skills. In addition, this is also relevant in supporting the Merdeka Belajar policy, which emphasizes contextual learning based on local culture (Kemendikbud, 2021).

2) Learning Approaches and Models

Analysis of 27 articles related to ethnoscience revealed that several studies explicitly stated the learning approaches and models employed. In contrast, other articles did not mention these elements in detail. A summary of the identified learning approaches and models is presented in Table 5 below.

Table 5. Ethnoscience-Based Learning Approaches and Models

No	Learning Approaches and Models
1	Ethnoscience Approach
2	Ethno-STEM Approach
3	RE-STEM (Religion-Ethnoscience-STEM) Approach
4	EthCBL (Ethnoscien Context-Based Learning) Approach
5	Project-Based Learning Model (E-PjBL)
6	Science Integrated Learning Model (SIL)
7	Ethnoscience-based "Course Review Horay" Model

The ethnoscience approach in learning aims to improve students' scientific literacy by connecting teaching materials with local culture and wisdom. By making learning more contextual and relevant, this approach helps students understand scientific concepts in everyday life (Sumarni, Wahyuni, & Muhtadi, 2020). One form of implementation is Ethno-STEM, which integrates aspects of STEM (Science, Technology, Engineering, and Mathematics) with local cultural elements. This approach strengthens students' STEM skills while enriching their understanding of traditional knowledge (Ikram, Kurniawan, & Lubis, 2022). In the context of education in Africa, Adedoyin and Belo (2021) found that integrating traditional knowledge with STEM can increase student engagement.

Another relevant approach is Ethnoscience Context-Based Learning (EthCBL), which combines science learning with students' cultural contexts. This approach makes learning more meaningful and applicable. According to Aikenhead and Michell (2011), context-based learning helps students understand science concepts that are relevant to their daily lives. Similar things were noted by Kim and Roth (2021), who emphasized that the integration of local culture supports students in linking scientific theories to real practices.

Another innovative approach is Religion-Ethnoscience-STEM (RE-STEM), which combines elements of religion, ethnoscience, and STEM. This model provides a learning experience that respects local religious and cultural values, making learning more meaningful (Rahmawati & Ridwan, 2017; Sumarni, 2018). In addition, Science Integrated Learning (SIL) supports the development of students' holistic understanding by integrating scientific theory and cultural practices (Lee, 2020).

The ethnoscience approach supports the main goal of science education, which is to improve contextual science literacy. Science literacy includes understanding scientific concepts, applying scientific processes, and developing scientific attitudes that are relevant to students' lives. With approaches such as EthCBL or RE-STEM, science learning becomes more personal and relevant, supporting the development of 21st-century skills (Hafsa, 2022; Ikram et al., 2022).

Interactive learning strategies also play a role in the ethnoscience approach. For example, the ethnoscience-based Course Review Horay integrates local cultural elements to increase student engagement and motivation, while reflecting science concepts in their cultural context (Wulandari, Supardi, & Putra, 2021). In addition, models such as ethnoscience-based Project-Based Learning (E-PjBL) engage students in local culture-based projects combined with scientific concepts. These projects include the creation of products based on traditional knowledge or exploration of local ecosystems to improve critical thinking skills and science literacy (Rahmawati & Taylor, 2017).

Learning approaches and models such as Project-Based Learning and Problem-Based Learning based on ethnoscience have also proven effective in increasing student engagement. This model focuses on real projects that are in accordance with local culture, supports student-centered learning, while preserving local wisdom. This strengthens students' cultural identity and

fosters a sense of pride in cultural heritage (Rahmawati & Ridwan, 2023; Sumarni et al., 2020).

Through an ethnoscience approach, learning not only strengthens students' academic knowledge but also fosters an appreciation for local culture. By connecting science with culture, students can better understand and apply scientific concepts in their daily lives. As a result, ethnoscience-based learning becomes more relevant, meaningful, and has a positive impact on student development (Yusuf et al., 2022).

Conclusion

The ethnoscience approach in science learning offers an innovative solution that integrates local cultural values with scientific concepts to increase the relevance and context of learning. Most studies show the flexibility of ethnoscience as an interdisciplinary approach that can be applied to various science concepts, although its application in biology is still low (7.40%). In contrast, physics and chemistry have a balanced proportion (18.52%), indicating the potential for greater integration through local cultural practices such as traditional technology and the use of natural materials. Ethnoscience-based learning media, such as modules, digital teaching materials, and student worksheets, help students develop critical and creative thinking skills. Ethnoscience-based learning approaches, such as Ethnoscience, Ethno-STEM, and RE-STEM, connect cultural values, religion, and modern science, thus creating more meaningful learning. In addition, project-based learning models, direct observation, and other interactive strategies strengthen students' holistic understanding of scientific concepts while supporting contextual science literacy.

Further research is needed to explore the potential of ethnoscience in biology and develop a wider variety of media, methods, and topics, such as natural pesticides, traditional measuring tools, and traditional toys. These efforts will enrich science learning, improve 21st century skills, and strengthen students' cultural identities, thus supporting contextual education that is relevant to everyday life.

Acknowledgments

The author would like to thank fellow students of the Science Education Doctoral Program at Semarang State University for their cooperation, inspiring discussions, and support. Your contributions and motivations are an important part of completing this article and making this academic journey more meaningful and memorable.

Author Contributions

"Conceptualization, Sudirman dan Dyah Rini Indriyanti; methodology, Sudirman dan Sutikno.; software, Sutikno; validation, Sudirman, Sutikno, and Dyah Rini Indriyanti; formal analysis, Sudirman; investigation, Sudirman; resources, Sutikno; data curation, Sudirman; writing—original draft preparation, Sudirman; writing—review and editing, Sudirman, Sutikno, dan Dyah Rini Indriyanti; visualization, Sudirman; supervision, Sutikno dan Dyah Rini Indriyanti; project administration, X.X. Dyah Rini Indriyanti. All authors have read and agreed to the published version of the manuscript."

Funding

This research received no external funding

Conflicts of Interest

The authors declare no conflict of interest

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