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Integration of Ethnoscience in High School Biology Learning: A Systematic Literature Review from 2021–2025

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Abstract

This study aims to analyze the development of studies on the integration of ethnoscience into biology learning in high schools during the 2021–2025 period. The method used was a systematic literature review (SLR) by searching articles through Google Scholar using keywords related to ethnoscience and biology education in high schools. A total of 30 articles met the inclusion and exclusion criteria and were analyzed through a process of identifying, reviewing, analyzing, and interpreting data. The results showed that the majority of studies focused on the development of ethnoscience-based learning tools (36.7%) and their implementation in the classroom (33.3%). In the domain of learning outcomes, the greatest improvement occurred in critical thinking skills (33.3%), followed by cognitive skills, scientific literacy, understanding of scientific concepts, and psychomotor skills. The material most frequently associated with local wisdom was biodiversity (29%). These findings confirm that ethnoscience is effective in strengthening conceptual understanding and higher-order thinking skills through a culturally relevant context.

Keywords: *Ethnoscience, Biology Learning, Systematic Literature Review, Local Wisdom*

INTRODUCTION

Ethnoscience plays a crucial role in improving the quality of biology learning because it combines modern scientific knowledge with cultural wisdom passed down through generations. The term ethnoscience itself comes from the Greek word "ethnos," meaning nation or community, and the Latin word "scientia," meaning knowledge. Simply put, ethnoscience refers to how a community understands nature and its environment through cultural

experiences (Musliha et al., 2023). This knowledge reflects the distinctive ways of thinking of a particular community and provides a rich and relevant learning resource. It is not surprising that ethnoscience approaches are increasingly being applied in biology learning, as they have been proven to enrich teaching methods and enhance student understanding.

In today's education, 21st-century skills such as critical thinking are a primary focus. The integration of ethnoscience into learning models, including problem-based learning, has been shown to stimulate students' critical thinking skills. Research shows that when ethnoscience is used alongside problem-based learning models, students become more active, analytical, and able to connect biological concepts to their real-life contexts (Oktapia et al., 2024). These findings demonstrate that ethnoscience is not only culturally relevant but can also serve as a strong foundation for fostering higher-order thinking skills.

Despite its significant potential, the integration of traditional knowledge into biology learning remains rarely reported (Andayani et al., 2024; Husni & Nasution, 2024). This situation indicates a research gap that needs attention, particularly regarding how local wisdom can be systematically incorporated into biology learning. Research trends in recent years also demonstrate a growing interest in exploring various forms of ethnoscience integration. This is evident in the emergence of keywords such as "Ethnoscience, PedaKapi, Biology Learning" or "Ethnoscience, Dayak Mualang, Classification of Living Things" (T. Andayani et al., 2025), which demonstrate the diversity of cultural contexts and biological materials being studied. Furthermore, the use of learning media such as booklets demonstrates the increasing variety of pedagogical strategies being developed.

The impact of ethnoscience on learning goes beyond improving critical thinking skills. Integrating cultural knowledge with science concepts also has the potential to improve scientific literacy, foster curiosity, and foster more positive scientific attitudes. When students perceive that biology material is close to their own culture, they tend to be more motivated and more easily grasp abstract concepts. However, to truly understand the extent of this approach's influence, a systematic review is needed that can map research developments, identify effective integration strategies, and evaluate their impact on various aspects of learning outcomes.

This systematic literature review was developed to address this need by examining research related to ethnoscience approaches in biology learning in depth. By synthesizing research characteristics, integration strategies used, and their effectiveness, this review is expected to provide a clearer understanding for educators and researchers who wish to utilize cultural richness as part of science learning. Thus, ethnoscience can continue to develop as an approach that not only preserves culture but also strengthens the quality of biology education.

RESEARCH METHODS

The method used in this research is a systematic literature review (SLR). The research applies a quantitative approach through descriptive statistical analysis to map and illustrate existing research trends. The SLR process involves identifying, reviewing, evaluating, and interpreting various relevant research documents. The review stages in this research include: (1) formulating research questions, (2) conducting a literature search, (3) establishing inclusion and exclusion criteria, (4) selecting literature that meets the criteria, (5) processing the data, (6) presenting the results in tables or graphs, and (7) drawing final conclusions (Triandini et al., 2019).

In the initial stage, the researcher divided the research topic into three main questions. This formulation of questions was done to systematically clarify the focus of the study and guide the data grouping and analysis process. The three questions that formed the basis of this research are: (1) What are the objectives of ethnoscience research in biology learning? (2) What are the student competencies studied in ethnoscience research in biology learning? (3) What material is discussed in ethnoscience research in biology learning?

In the second stage, researchers collected scientific articles from journals and proceedings. The articles were obtained through a Google Scholar search using the keywords "("ethnoscience" OR "ethnosains) AND ("biologi" OR "PendidikanBiologi" OR "biology" OR "biologyeducation") AND ("SMA" OR "highschool")". Next, in the third and fourth stages, the researcher screened the collected articles by applying the inclusion and exclusion criteria as listed in Table 1. Through this screening process, 30 articles were obtained that met the requirements and were suitable for further analysis. The inclusion-exclusion stage was carried out to ensure that the articles used were relevant, up-to-date, and of adequate quality.

Table 1. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Articles on the topic of ethnoscience in biology learning in high school	Articles not on the topic of ethnoscience in biology learning in high school
Articles published in 2021-2025	Articles not published in 2021-2025
Articles sourced from journals or proceedings	Articles sourced from journals or proceedings Proceedings

In the fifth stage, articles meeting the criteria were analyzed using a descriptive statistical approach. Afterward, each article was grouped based on the research objective, the student competencies being measured, and the biology material discussed. In the sixth stage, the analysis results were presented in tables and graphs, then systematically interpreted and described. In the final stage, the researchers compared the findings with those of other relevant studies and drew conclusions from the entire review process.

RESULTS AND DISCUSSION

Objective Study Ethnoscience in Learning Biology 2021-2025

Based on the 30 articles analyzed, the research objectives of ethnoscience in biology learning show quite clear variations in focus. Each article is grouped by research orientation to examine trends in the development and application of ethnoscience in high schools. The distribution of these research objectives can be seen in Table 2.

Table 2. Objectives Study Ethnoscience in Learning Biology

Objective Study	Amount	Frequency
Development module / media / LKPD / book pocket based ethnoscience	11	36.7%
Implementation / influence ethnoscience to learning	10	33.3%
Identification local wisdom that can made into as teaching materials biology	3	10%
Booklet/media validation	2	6.6%
Profile knowledge ethnoscience biology teacher in high school	2	10.6%
Analysis suitability local wisdom with learning biology	1	3.3%
Perspective student related utilization local wisdom as material study material biology	1	3.3%

The literature mapping results indicate that research on ethnoscience in biology learning in the 2021–2025 period is dominated by two main focuses: the development of ethnoscience-based learning tools and the implementation or testing of ethnoscience's influence on the learning process. These two categories have relatively equal numbers: 11 studies on development (36.7%) and 10 studies on implementation (33.3%), thus, combined, they account for more than two-thirds of the total research analyzed. This dominance indicates that the discourse on ethnoscience is no longer merely conceptual but has moved toward practical

application in the form of concrete teaching materials and learning strategies. Researchers appear to be striving to actualize local wisdom in modules, media, student worksheets (LKPD), and pocketbooks, while also examining the extent to which these innovations can improve the quality of biology learning in an educational context that is more relevant to students.

Research on tool development shows that ethnoscience is increasingly recognized as an approach capable of bridging abstract biological concepts with local cultural realities (Sari et al., 2024; Pusparani & Selamat, 2021; Amalina et al., 2024; Andayani et al., 2025; Rosidi et al., 2023; Ningrum et al., 2025; Marsaoly, 2024; Zubaedah et al., 2025; Arifin et al., 2024; Solviana et al., 2024; Marsila et al., 2025). The resulting learning products generally utilize cultural phenomena, traditional community practices, local knowledge about the environment, or local technology as authentic learning contexts. This demonstrates a strong tendency to create meaningful learning, where students not only understand biological concepts but can also relate them to their life experiences and familiar cultures (Usman et al., 2022).

In addition to tool development, research on the implementation of ethnoscience in learning accounts for 36.7% (Jumiati, 2023; Yasir et al., 2022; Y. Andayani et al., 2024; Nurjanah et al., 2024; Fitri et al., 2023; Haryanto, 2023; Fuadi, 2024; Jacinda, 2023; Nurhasnah, 2022; Oktapia et al., 2024; Aisah et al., 2023). This demonstrates a strong interest in examining how ethnoscience is directly applied in the classroom and how this approach can support the biology learning process. These findings confirm that ethnoscience is not only developed as a concept but also tested for its effectiveness in improving understanding, motivation, critical thinking skills, and other aspects of student learning outcomes, as well as fostering better ecological attitudes. The balance between development and implementation research indicates a healthy research cycle: developed tools do not stop at the design stage, but are piloted, evaluated, and reflected upon to assess their impact in real-life learning contexts.

Beyond these two main categories, only two studies (6.6%) addressed the validation of booklets or media (Taher et al., 2025; Zubaedah et al., 2025). This low number indicates that the formal validation stage has not yet become a primary focus in ethnoscience research. Expert validation is crucial for ensuring that learning tools meet pedagogical standards, the appropriateness of biological content, and the accuracy of integrating local wisdom. The lack of validation research also indicates that many tools are used directly at the implementation stage without adequate quality assurance. This has the potential to cause problems, particularly regarding the credibility of the material, user acceptability, and broader learning effectiveness.

More fundamental research, such as analyzing the suitability of local wisdom for biology learning, was found in only one study (3.3%) (Dzurrahmi, 2023). This very limited

number indicates that conceptual aspects of the relationship between local culture and biology content are rarely studied in depth. Yet, such conceptual analysis is crucial to ensure that ethnoscience integration is not merely superficial, decorative, or merely the symbolic inclusion of cultural elements, but is truly based on the epistemological and pedagogical suitability between local science and modern science.

In contrast, research focused on identifying local wisdom as a source of biology teaching materials was found in three studies (10%) (Musliha et al., 2023; Anzelina, 2023; Muchsin et al., 2023). Although not numerous, this research category is highly strategic as it serves as a gateway for developmental research. This identification generally results in a list of local knowledge, community practices, or environmental phenomena unique to a particular region that can be used as context for biology learning. Without a robust identification stage, development research has the potential to use local wisdom that is irrelevant or inappropriate for the biology content being taught.

Research exploring student perspectives regarding the use of local wisdom in learning was only found in one study (3.3%) (Nur et al., 2025). The limited number of studies examining student voices indicates that the process of integrating ethnoscience is primarily viewed from the perspective of tool developers or researchers, rather than from the perspective of end users. Yet, student perceptions are crucial in ensuring that ethnoscience-based learning is not only academically effective but also accepted, enjoyed, and perceived as relevant by students. Without understanding student perspectives, there is the potential for the tools or approaches developed to be inappropriate for their needs, interests, or learning styles.

Finally, research on the ethnoscience knowledge profile of biology teachers in high schools was also found in only two studies (6.6%) (Rikizaputra et al., 2021; Festiyed et al., 2022). This number indicates that teacher competency, as key actors in ethnoscience implementation, has not received much attention in research. The results of these studies indicate that teachers still struggle to integrate ethnoscience into biology learning. However, teachers' understanding of ethnoscience, their ability to integrate local wisdom into their learning, and their pedagogical readiness are crucial for the success of ethnoscience implementation in the classroom. Without the support of competent and confident teachers, ethnoscience-based learning tools, no matter how good, will not have an optimal impact.

Student Competencies Studied in Ethnoscience Research in Biology Learning 2021-2025

In addition to the research objectives, the analysis was also conducted to identify student competencies that were the focus of ethnoscience studies in biology learning during

the 2021-2025 period. Each article was mapped based on the type of learning outcome measured, revealing trends in the most frequently researched competencies. Mapping of targeted learning outcomes in research on the application of ethnoscience in biology learning, 2021-2025, shows that the most dominant focus of improvement is critical thinking skills, recorded in 9 studies (33.3%). Furthermore, cognitive outcomes also received significant attention, with 4 studies (15%), followed by improvements in scientific concept understanding and scientific literacy, each with 3 studies (11%). Two studies (7%) targeted psychomotor skills. Several other learning outcomes emerged with lower percentages, such as environmental awareness, learning motivation, learning activities, collaboration, and problem-solving skills, each with only 1 study (3%). In general, the targeted outcomes were more focused on higher-order thinking and strengthening conceptual mastery, while the affective, social, and psychomotor domains were relatively rarely the focus of research. Details of the distribution of these competencies are presented in Figure 1.

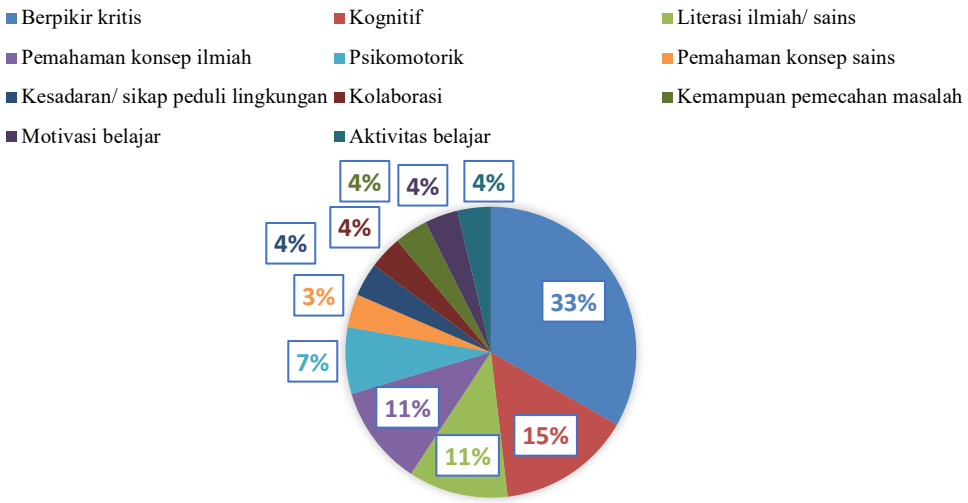

Figure 1. Distribution of Student Competencies Studied in Ethnoscience Research in Biology Learning 2021-2025

The research results, which focused on critical thinking as the primary target (30%), reflect the researchers' understanding that ethnoscience is highly effective in developing higher-order thinking skills (HOTS). By contextualizing biological concepts into local cultural practices or ethnobiological phenomena, students are confronted with situations where they must analyze, evaluate, and create new meanings from local experiences. Research by Sari et al. (2024) found that the effectiveness of ethnoscience-based learning media in improving critical thinking skills was 47%, which is considered moderate. Research conducted by Septiani

and Listiyani (2021) showed that the ethnoscience-based module they developed was more effective than conventional teaching materials because it included components that trained students' critical thinking skills. The module included various open-ended questions to observe students' thought processes, conceptual questions to initiate problem-solving, and Socratic questions that helped students develop ideas about the subject matter. Learning occurs when students actively construct knowledge through interactions with their cultural environment and critical reflection on those experiences.

The significant focus on cognitive domains (15%), understanding of scientific concepts (11%), and scientific literacy (11%) supports the idea that ethnoscience also functions as an advance organizer. Within the framework of Ausubel's theory of meaningful learning, local knowledge (ethnoscience) acts as a bridge (organizer) linking abstract biological concepts to students' concrete experiences (Dewi et al., 2021). Thus, ethnoscience helps students internalize scientific ideas through familiar cultural contexts, improving knowledge retention and transfer (Septiani & Listiyani, 2021), and enhancing scientific literacy (Andini et al., 2022; Yasir et al., 2022). A literature review conducted by Nurhasnah et al. (2022) found that the ethnoscience approach has a significant impact on helping teachers improve students' understanding of scientific concepts.

Research targeting psychomotor skills (7%) indicates that ethnoscience addresses not only the theoretical realm but also real-world practice. Based on research by Zubaedah et al. (2025), they stated that the developed ethnoscience e-module can improve students' cognitive and affective abilities and demonstrate their increased curiosity about fermentation technology. Experiments based on local community knowledge reflect the cycle of concrete experience, reflection, conceptualization, and experimentation, as described in Kolb's Experiential Learning (EXPERIENCE) theory. Through hands-on practice, students not only understand biological theory but also acquire laboratory skills, procedural skills, and observation techniques based on the local context.

Affective aspects such as environmental awareness, learning motivation, and meaningful learning experiences emerged, albeit at a low frequency (3% each). However, the presence of these targets is significant because it indicates that ethnoscience is also seen as a medium for shaping students' ecological attitudes and emotional connections with culture and nature. Applying an ethnoscience approach to learning can increase students' enthusiasm for learning (Jumiati, 2023).

Furthermore, the emergence of targets for collaboration, learning activities, and problem-solving skills (3% each) indicates that several studies utilize ethnoscience as a means

of social learning. Overall, this pattern of learning outcome targets indicates that the application of ethnoscience in biology learning is directed not only at improving conceptual understanding, but also at developing critical thinking skills, practical skills, and ecological character values. However, the low frequency in several domains (affective, social, and literacy) indicates untapped potential in ethnoscience research. Going forward, it is important for further research to further explore the affective and collaborative aspects, in order to realize biology learning that is not only cognitive but also holistic and rooted in local culture.

Material Discussed in the 2021-2025 Research on Ethnoscience in Biology Learning

In addition to learning objectives and competencies, this study also mapped the biology material used as the context for ethnoscience integration in publications from 2021–2025. This selection of material aimed to identify topics most frequently associated with local wisdom and to understand the scope of ethnoscience application in the high school biology curriculum during that period. The analysis revealed a variety of material, ranging from ecological concepts to human body systems. The complete distribution of the material discussed is presented in Figure 2.

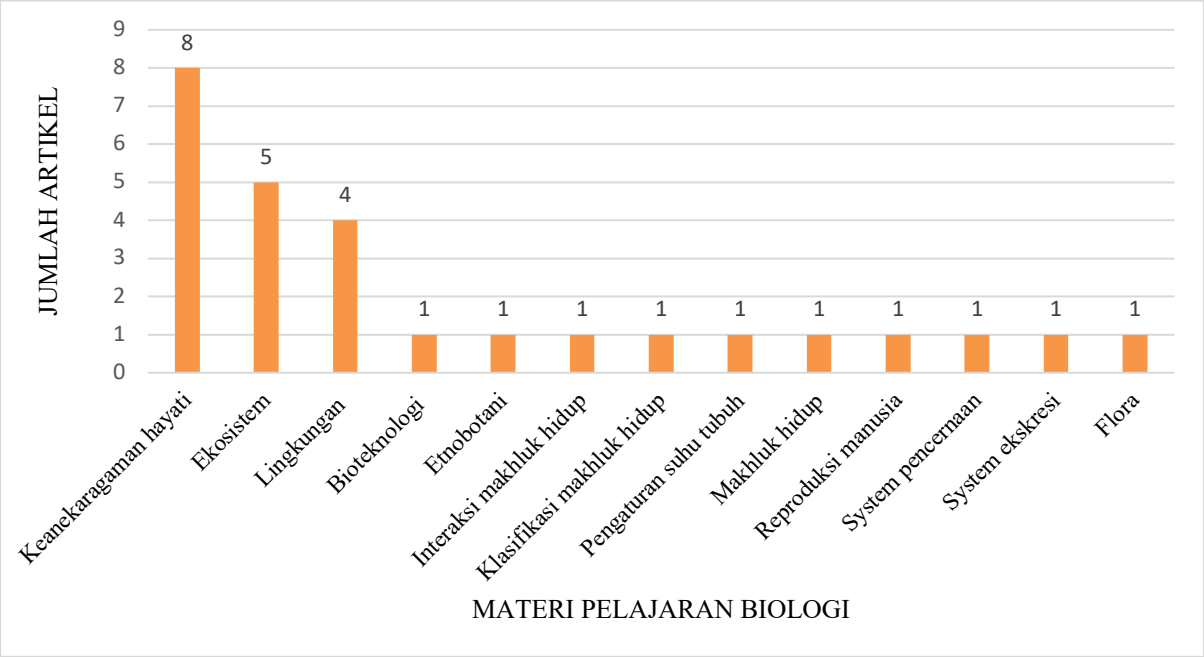

Figure 2. Distribution of Material Discussed in Ethnoscience Research in Biology Learning 2021-2025

The analysis of publications from 2021–2025 shows that the selection of materials in the application of ethnoscience in biology learning is strongly influenced by the material's proximity to the context of community life. This finding is evident from the dominance of

biodiversity material that appears in 29% of studies (Jumiati, 2023; Musliha et al, 2023; Amalina et al, 2024; Taher et al, 2025; Oktapianur and Ramdiah, 2025), making it the material most frequently integrated with local wisdom. Biodiversity provides a broad space for combining biological concepts and traditional knowledge, such as the use of several types of plants for making traditional weaving tools. Among the types of plants used are bamboo (Dendrocalamus asper), tamarind (Garcinia xanthochymus hook.), and coconut (Cocus nucifera) whose stems are used to make parts of traditional weaving tools (Dzurrahmi, 2023). In this context, ethnoscience functions as a link between scientific epistemology and local epistemology so that students not only understand biological concepts but also see the scientific value in the knowledge heritage of their community. This is in accordance with the research results (Anggelya et al, 2025) which states that the use of local wisdom such as the coffee processing process in Jember in the context of learning biology on biodiversity material can be an effective means for students to understand science concepts through contextual issues that are closely related to students' lives.

Ecosystems (Oktapia et al., 2024; Oktapia et al., 2024; Oktapianur and Ramdiah, 2025) and the environment (Andayani et al., 2025; Oktapianur and Ramdiah, 2025) also occupy significant proportions, at 18% and 14%, respectively. Both are focused on their characteristics, which directly intersect with community cultural practices, for example, traditional land management systems, customary fishing practices, community-based conservation regulations such as sasi, and local wisdom in maintaining the balance of nature. The integration of ethnoscience in these two materials reinforces contextual learning theory, which states that academic concepts become more meaningful when linked to students' concrete experiences. Thus, ethnoscience-based ecosystem learning not only facilitates understanding of scientific concepts but also builds ecological awareness rooted in cultural identity. These findings indicate that materials easily observed in everyday life, or those directly correlated with cultural practices, are most easily applied to ethnoscience. This reinforces the perspective that the learning process cannot be separated from the cultural environment in which students live. Therefore, teachers and researchers tend to choose materials that provide a concrete context for connecting local culture with scientific concepts.

However, other materials, such as biotechnology (Anzelina, 2023), ethnobotany, interactions between living things (Pusparani and Selamat, 2021), classification of living things (Musliha et al., 2023), body temperature regulation, living things, human reproduction, flora, the digestive system, and the excretory system, each only appear at around 3%. This low representation of these materials indicates a gap between the truly rich potential of ethnoscience

and efforts to integrate it into specific biological materials. For example, traditional biotechnologies such as fermentation, herbal medicine production, or local food preservation techniques are actually very relevant to modern biotechnology materials, but have not been widely utilized as learning resources. This may be due to teachers' limited knowledge of the relationship between cultural practices and modern biological concepts, or to a learning paradigm that is still predominantly textbook-oriented, rather than community-based. Meanwhile, research (Zubaedah et al., 2025) shows that ethnoscience-based modules on biotechnology can improve the quality of the learning process and student learning outcomes across the board, providing learning experiences that are not only academically meaningful but also socially and culturally meaningful.

Similarly, topics such as the digestive and excretory systems have significant potential to be linked to traditional health practices, the use of medicinal plants, or dietary restrictions in certain customs. However, the limited exploration of these topics indicates that the implementation of ethnoscience is still more focused on ecological aspects than physiological ones. The limited selection of topics on human reproduction also reflects the social and cultural sensitivities often considered by teachers and researchers. The integration of ethnoscience into these topics requires more careful strategies to avoid clashing with local values. The same is true for body temperature regulation and the interactions of living things. While they have the potential to integrate with local knowledge (e.g., animal behavior in local cultures or traditional health practices), they have not been widely explored scientifically.

Meanwhile, the presence of ethnobotanical material, even in only 3% of publications, demonstrates the explicit efforts of some studies to enhance community knowledge regarding the use of local plants. However, this low number of publications confirms that ethnobotany, a very rich branch, has not been optimally utilized as a basis for culture-based biology learning. This is despite the literature showing that ethnobotany is one of the most natural pathways for connecting biology with socio-cultural contexts.

Overall, the results of this study indicate that the integration of ethnoscience in biology learning still focuses on material containing ecological aspects and easily observed in everyday life. Meanwhile, material that is abstract, sensitive, or requires conceptual translation between culture and science tends to attract less interest from researchers. This situation opens up opportunities for further research to expand the scope of ethnoscience, especially in materials that have previously been understudied. By broadening the scope, biology learning not only becomes more contextual, but also more socially relevant and more appreciative of the diversity of knowledge that lives in society.

CONCLUSION

A literature review of 30 research articles on ethnoscience in biology learning from 2021 to 2025 shows that ethnoscience is increasingly being applied in the form of learning tool development and classroom implementation. This approach has proven most effective in improving students' critical thinking skills, followed by cognitive domains, scientific literacy, and understanding of scientific concepts. In terms of material, biodiversity, ecosystems, and the environment are the topics most frequently associated with local wisdom. These results confirm that ethnoscience can strengthen biology learning that is contextual, relevant, and culturally close to students. However, exploration of other biology materials and studies related to teacher competency are still limited, requiring further research.

Further research is recommended to expand the application of ethnoscience to less-developed biology materials so that the integration of local wisdom encompasses more learning concepts. The development of learning tools needs to be accompanied by stronger validation so that the resulting products are truly suitable for classroom implementation. Furthermore, studies on teacher competency and readiness in using ethnoscience need to be improved, as their role is crucial for learning success. It is also important for future research to involve students' perspectives so that ethnoscience approaches are more suited to their needs and learning experiences.

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