Studies in Philosophy of Science and Education
Homepage: https://scie-journal.com/index.php/SiPoSE
Email: sipose@scie-journal.com

p-ISSN: 2722-3523; e-ISSN: 2721-9267
SiPoSE, Vol. 5 No. 3, November 2024: 150-162
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Assessment of Teaching Modules as Physics Teachers' Review of Ethnoscience Issues in the Context of *Rebana*

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Article Info

Article history:

Received July 9, 2024
Revised September 3, 2024
Accepted October 28, 2024
Available Online November 30, 2025

Keywords:

Challenges;
Ethnophysics;
Problems;
Science literacy;

ABSTRACT

This study aims to assess an ethnoscience-based physics learning module in the context of *rebana* from the perspective of science and engineering teachers, focusing on the relevance of scientific content to local culture, the dimensions of scientific literacy, and the module's contextual appeal and associated challenges. Employing a mixed-methods approach with an explanatory design, the study began with the collection of quantitative data using a Likert-scale instrument administered to 40 purposively selected respondents, followed by in-depth interviews to explore contextual ethnoscience issues and the types of support needed. The results indicated that most respondents provided highly positive feedback on the integration of physics content with ethnoscience, evaluating the module as an effective and engaging learning tool. However, challenges persist, particularly regarding teachers' limited understanding, lack of relevant learning resources, and the difficulty of connecting local culture with abstract scientific concepts. Therefore, support in the form of professional development, the creation of contextual learning media, cross-sector collaboration, and adaptive educational policies is essential to ensure the effective and sustainable implementation of ethnoscience-based physics learning.

https://doi.org/10.46627/sipose

INTRODUCTION

Preserving local culture through education plays a vital role in maintaining the identity and values of local wisdom amid the forces of globalization. This knowledge encompasses various essential aspects of life, including agriculture, environmental management, traditional medicine, belief systems, and cultural practices that have been proven to sustain ecological balance and support community well-being (Suprapto & Yusuf Santoso, 2024). Education that integrates elements of regional culture can instill a sense of pride and ownership in younger generations toward their cultural heritage. Learning based on local wisdom contributes to the protection and preservation of a community's cultural heritage and traditions—key components of cultural identity and sustainability (Lestari et al., 2022). Moreover, this approach enriches the educational experience by providing content that is closely connected to students' everyday lives. The findings of research indicate that educational approaches rooted in local wisdom can foster a deeper connection between individuals and their cultural identities (Maftuh et al., 2025; Sakti et al., 2024).

The lack of local cultural representation in science education, particularly in physics, poses a significant barrier to achieving contextual and meaningful learning. Physics content in schools is often presented through abstract concepts that are disconnected from students' social and cultural realities. Many educators do not actively develop or utilize instructional materials that incorporate elements of local culture, resulting in a disconnect between students' everyday lives and their educational experiences (Syahda & Deta, 2023). Furthermore, physics curricula frequently lack explicit integration of the nature of science and local cultural contexts, instead emphasizing theoretical knowledge without practical or relatable applications (Sengul, 2024; Sharkey & Chini, 2024). This gap makes it difficult for students to connect physics concepts with real-life experiences. In reality, many traditional cultural practices—such as the use of local musical instruments or indigenous technologies—embody fundamental physics principles and offer rich, engaging opportunities for contextualized science learning.

Ethnoscience aligns well with contextual learning approaches, as both emphasize connecting subject matter to students' real-life experiences. Through ethnoscience, students can grasp scientific concepts by engaging with cultural practices that are familiar and personally meaningful to them. This approach not only enhances conceptual understanding but also fosters a deeper appreciation for local wisdom. Integrating local knowledge into physics education enables students to relate abstract concepts to their cultural experiences (Widiyawati et al., 2023). The publication trends in Ethnoscience in Physics Learning (EPL), which have shown annual fluctuations with a notable increase since 2000 and a peak in 2021, along with the prominence of studies in astronomical physics followed by the social sciences and humanities—highlighting social, cultural, and psychological dimensions in physics learning—indicate the growing relevance of ethnoscience. This approach aligns well with the goals of the Independent Curriculum, which encourages pedagogical innovations rooted in local culture to create adaptive, relevant, and student-oriented learning environments (Sunarti et al., 2024).

Ethnoscience in education serves as a bridge between modern science and the traditional cultures embedded in society. Integrating local wisdom into science education enables students to grasp scientific concepts through familiar cultural and environmental contexts, thereby narrowing the gap between local and global knowledge and emphasizing the practical relevance of science in daily life (Suprapto & Santoso, 2024). The primary aim of science education is to help students understand the natural environment and surrounding phenomena through a scientific lens—one effective approach being the incorporation of local wisdom that aligns with the dynamics of global development. As a subfield of ethnoscience, ethnophysics explores the relationship between physical concepts and culture, focusing on how communities interpret and engage with natural phenomena through traditional knowledge, while also valuing cultural heritage and local perspectives on the physical world. In Indonesia, numerous traditional cultural practices contain principles of physics that can be harnessed as contextual learning resources. For instance, the tambourine (*rebana*) produces sound through vibration and resonance—fundamental concepts in the study of sound waves. The way it is played, the materials used, and the size of the membrane or metal plate all influence the frequency and intensity of the sound produced.

The *rebana* is a traditional musical instrument deeply rooted in the Islamic culture of the Indonesian archipelago. Believed to have entered Indonesia as early as the 13th century through the spread of Islam—popularized by figures such as Habib Ali bin Muhammad bin Husain Al-Habsyi, who used the *rebana* and *shalawat* as tools for preaching—it has since evolved into a significant element of community culture. Historical records indicate that the *rebana* gained widespread use in the 16th century and continued to flourish, particularly after 1945, through religious gatherings and *kasidah* assemblies that have helped preserve this traditional art. The *rebana* is often featured in various traditional rituals and ceremonies, blending local customs with Islamic values to create a unique form of syncretic art. Beyond its function as a musical instrument, the *rebana* embodies religious significance and serves as a symbol of communal cultural identity. In Javanese traditions, *rebana* performances carry spiritual meaning, reinforcing

https://doi.org/10.46627/sipose.v5i3.677

social bonds and promoting nationalism through musical expression (Purwadi, 2022). Within the broader Nusantara Islamic tradition, the *rebana* frequently accompanies *salawat* and *dhikr* during religious events such as the Prophet Muhammad's birthday and Islamic holiday commemorations. Religious music groups like *Sohibu Baiti* in Mandar have played an important role in preserving and popularizing *rebana* music, both as an expression of cultural identity and as a medium of religious outreach (Hafid et al., 2022). Additionally, the *rebana* features prominently in traditional processions and celebrations—such as weddings and circumcisions—enhancing the sacred atmosphere while fostering social unity through vibrant cultural expression.

The *rebana* is a traditional musical instrument that operates on the principle of a closed organ pipe—a tube with one end sealed by a skin membrane, forming an air column that produces standing (stationary) waves. In this system, a node is formed at the closed end and an antinode (belly) at the open end, allowing the instrument to produce distinct sounds when struck. The "dung" sound is generated when the *rebana* is struck in the center, causing the hand to bounce off the surface, while the "tak" sound occurs when the edge is struck with the hand remaining pressed. These two contrasting sounds serve as the foundation for tone and rhythm in *rebana* performance (Bektiarso et al., 2023). The "tak" sound is generally louder than the "dung" sound, resulting in greater finger recoil for the latter, while the "tak" often involves sustained contact.

When the air column inside the *rebana* vibrates, it resonates at its natural frequency—a condition where the frequency of the air vibration matches the natural frequency of the pipe, amplifying the sound through resonance. Resonance is a physical phenomenon in which one system vibrates at the same frequency as another nearby system, thereby transferring energy efficiently. This phenomenon gives rise to standing sound waves within the air column (Giancoli, 2014). In a closed organ pipe, the open end exhibits maximum air displacement (antinode), while the closed end shows zero displacement (node), a characteristic essential to understanding the acoustics of the *rebana*.

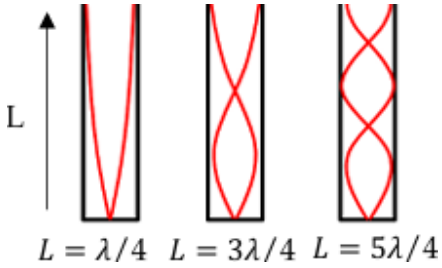


Figure 1. Standing wave pattern of a closed organ pipe (Abdullah, 2017)



Figure 2. *Rebana* musical instrument from Gresik craftsmen.

The tambourine is a musical instrument with a circular shape resembling a flat tube, characterized by a fixed base, an open end, and a cylindrical body (Mu'asaroh & Noor, 2021). The sound waves produced by the tambourine are standing waves that exhibit a fundamental frequency (first harmonic), as well as higher harmonics such as the second and third (Bektiarso et al., 2023). Accordingly, these sound patterns can be described using the appropriate wave equations (Abdullah, 2017). While the tambourine is widely recognized and understood by the Indonesian public, its potential as a learning medium—particularly in science education—

remains underutilized, especially in the context of physics instruction (Nugraha & Prabowo, 2022). A qualitative study has shown that the physics concepts involved in playing the tambourine can serve as valuable teaching tools in science classrooms (Bektiarso et al., 2023).

Teachers serve as mediators who bridge scientific content with students' local cultural contexts. By understanding their students' cultural backgrounds, teachers can present material in ways that are more relevant and accessible. Their mediating role is crucial in addressing potential conflicts between curricular content and cultural perspectives through a structured process, thereby fostering harmonious classroom relationships and promoting an effective learning environment (Katamadze et al., 2024). This approach enables students to connect scientific concepts with everyday experiences, making learning more meaningful. Furthermore, the quality of teacher–student relationships significantly influences science achievement by fostering intellectual curiosity, which serves as a key mediator in cultivating a supportive atmosphere and encouraging deeper engagement with scientific ideas (Ali et al., 2024).

Teachers' perspectives are key in assessing the relevance and effectiveness of ethnoscience-based modules in education. As central figures in contextualizing science instruction, teachers play an active role in aligning learning strategies with local cultural values to create more meaningful and engaging learning experiences (Widiyawati et al., 2023). Given their direct interaction with students and deep understanding of learners' needs and characteristics, teachers are well-positioned to evaluate whether a module is appropriate for the classroom context—especially when supported by ethnoeducational competencies that enable them to build trust and incorporate cultural elements into instruction, fostering an inclusive environment that respects diversity. Their experience in applying various instructional strategies further allows them to provide valuable feedback on the strengths and limitations of ethnoscience content, including the identification of cultural gaps and the adaptation of modules to remain relevant and effective in multicultural learning settings. Therefore, teacher assessments are crucial to ensuring that the integration of local culture meaningfully contributes to achieving the goals of physics education.

This study aims to evaluate an ethnoscience-based physics learning module in the context of *rebana* from the perspective of science and engineering teachers. The focus includes the alignment between science and technology content and local cultural elements, the dimensions of scientific literacy reflected in the module, and the extent to which the module identifies the appeal, issues, and contextual challenges of ethnoscience. Accordingly, this study is expected to provide a comprehensive overview of the module's relevance and effectiveness in supporting contextual and meaningful physics learning.

RESEARCH METHOD

This study utilizes a mixed-methods approach with an explanatory design, combining quantitative and qualitative methods sequentially. In the initial stage, quantitative data was collected and analyzed, followed by qualitative data to deepen and strengthen the previous findings. This approach was chosen because it provides a more comprehensive understanding of the phenomenon under study through the integration of two forms of data (Creswell, 2018; Pane et al., 2022).

In the quantitative stage, the teaching module was assessed based on three aspects using a Likert scale instrument, and a purposive sample of 40 people was selected from several regions who were teachers and students majoring in science and engineering. This technique was chosen to allow researchers to select respondents who had high expertise or relevance to the focus of the study without aiming to generalize (Sugiyono, 2013). The data were analyzed using percentage values. The qualitative stage was conducted through interviews to explore in depth the contextual issues of ethnoscience in the module, as well as the forms of support expected by respondents to develop ethnoscience-based physics learning, so that a comprehensive conclusion could be obtained from the integration of both data sets. The data were described using descriptive analysis in the discussion.

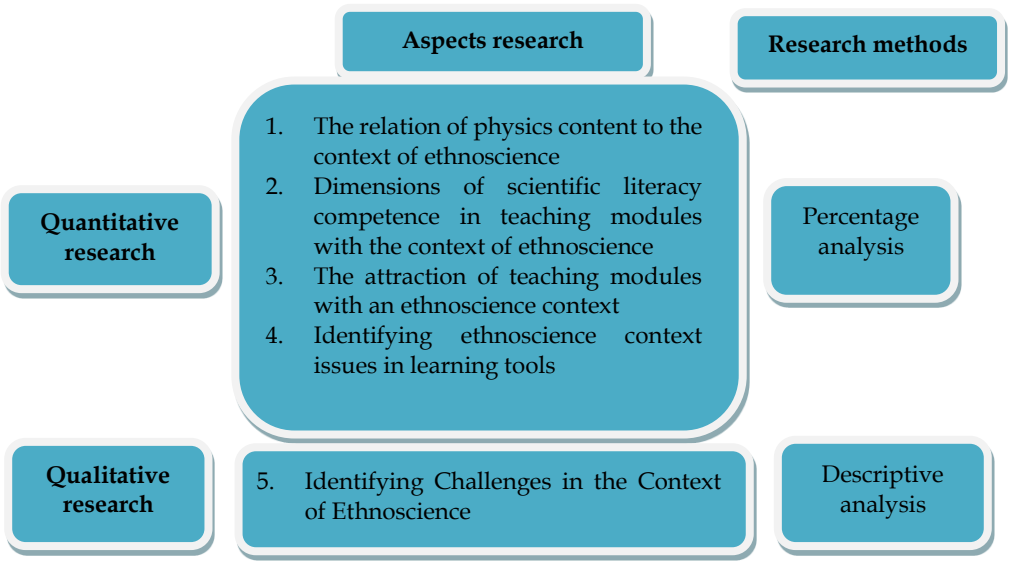


Figure 3. Mixed-method research flow used

RESULTS AND DISCUSSION

A deep understanding of local wisdom is a key factor in designing contextual learning that is both effective and relevant to students' needs. While the importance of differentiated instruction and contextual teaching is widely recognized, implementing these approaches remains challenging without sufficient support and understanding of local cultural knowledge (Widiyawati et al., 2023). This highlights that although teaching experience is a valuable asset, educators still require targeted support and training to integrate ethnoscience effectively within a continuously evolving curriculum. Experienced teachers may possess greater awareness of how to incorporate ethnoscience into instruction; however, they often face challenges in balancing the expectations of both traditional and modern educational paradigms (Widiyawati et al., 2023). Extended teaching experience can enhance teachers' ability to meaningfully connect scientific concepts with local cultural contexts in ways that are pedagogically appropriate and impactful.

Table 1. Respondent's period of teaching experience

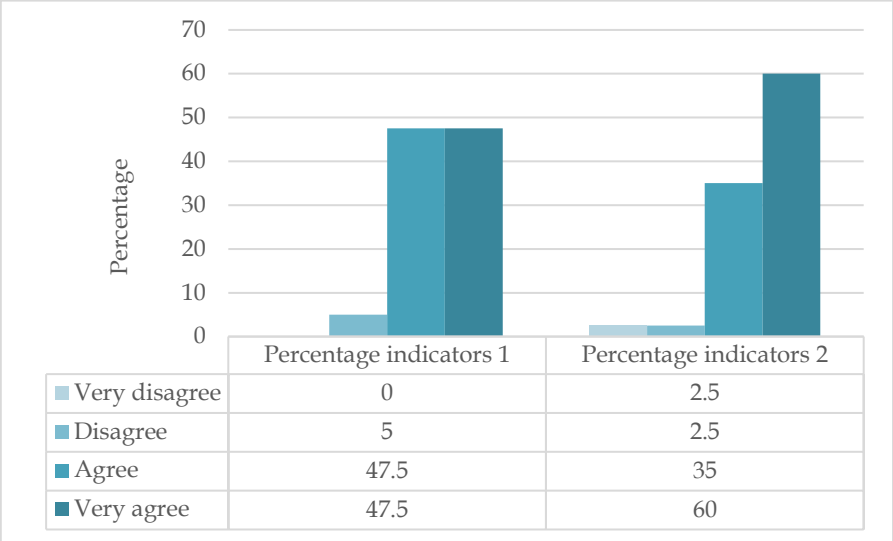
Teaching Experience	Total of section from 40 respondents	Percentage (%)
Less than 1 year	25	62,5
1-5 years	12	30
5-10 years	0	0
More than 10 years	3	7,5
Total	40	100

The majority of respondents in this study were teachers and prospective teachers (students majoring in education, particularly in science and engineering) with varying levels of teaching experience. Of the 40 respondents, 62.5% had less than one year of teaching experience, 30% had between one and five years, and only 7.5% had more than ten years of experience. Respondents were from various regions across Indonesia—such as Gresik, Jombang, Lamongan, Madiun, Mojokerto, Nganjuk, Ngawi, Pamekasan, Pasuruan, Probolinggo, Sidoarjo, North Sumatra, Sumenep, and Surabaya—reflecting a diverse range of geographical backgrounds within the study.

The Relation of Physics Content to the Context of Ethnoscience

The ethnoscience module plays a vital role in fostering meaningful and contextual learning by integrating local wisdom and cultural knowledge into the curriculum. It is evaluated based on its effectiveness in embedding these cultural elements, thereby enhancing the relevance and

authenticity of the learning experience (Widiyawati et al., 2023). This integration enables students to grasp scientific concepts through experiences and cultural values closely related to their daily lives. In this study, two indicators adapted from Prabawati (2023) were used to assess the relevance of physics content to ethnoscience: (1) alignment with the Merdeka Belajar (Independent Learning) curriculum, which emphasizes core materials connected to the real-life context of local culture, and (2) the extent to which the cultural context supports students in more easily understanding physics concepts.

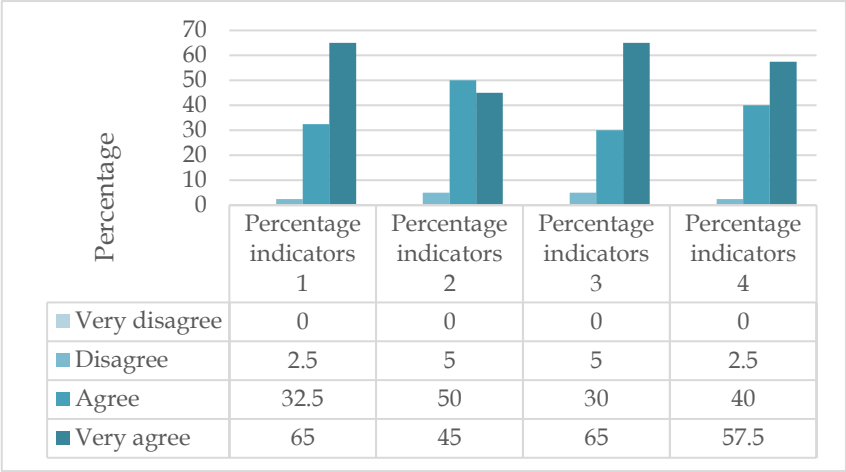


	Percentage indicators 1	Percentage indicators 2
Very disagree	0	2.5
Disagree	5	2.5
Agree	47.5	35
Very agree	47.5	60

Figure 4. The relation of physics content to the context of ethnoscience

The data presented in Figure 4 indicate that the majority of respondents gave positive responses regarding the relevance of physics content to the ethnoscience context. For Indicator 1, 47.5% of respondents agreed and another 47.5% strongly agreed, while only 5% disagreed. In Indicator 2, support was even stronger, with 60% strongly agreeing and 35% agreeing—demonstrating a growing positive perception of the relevance of ethnoscience in physics education. In the Indonesian context, ethnoscience research emphasizes the importance of cultural relevance in science instruction, showing that well-designed modules can enhance the overall effectiveness of education (Muyassaroh et al., 2025).

Dimensions of Scientific Literacy Competence in Teaching Modules with the Context of Ethnoscience



	Percentage indicators 1	Percentage indicators 2	Percentage indicators 3	Percentage indicators 4
Very disagree	0	0	0	0
Disagree	2.5	5	5	2.5
Agree	32.5	50	30	40
Very agree	65	45	65	57.5

Figure 5. Dimensions of scientific literacy competence in teaching modules within the context of ethnoscience

The relationship between the dimensions of scientific literacy competencies in the teaching module and the ethnoscience context is significant, as it enhances student engagement and understanding of scientific concepts through a culturally relevant framework. In this study, four indicators were adapted from the OECD (2023) framework: (1) engaging students in explaining phenomena scientifically, (2) evaluating the design of scientific investigations, (3) interpreting scientific data and evidence critically, and (4) assessing scientific information for use in decision-making and action.

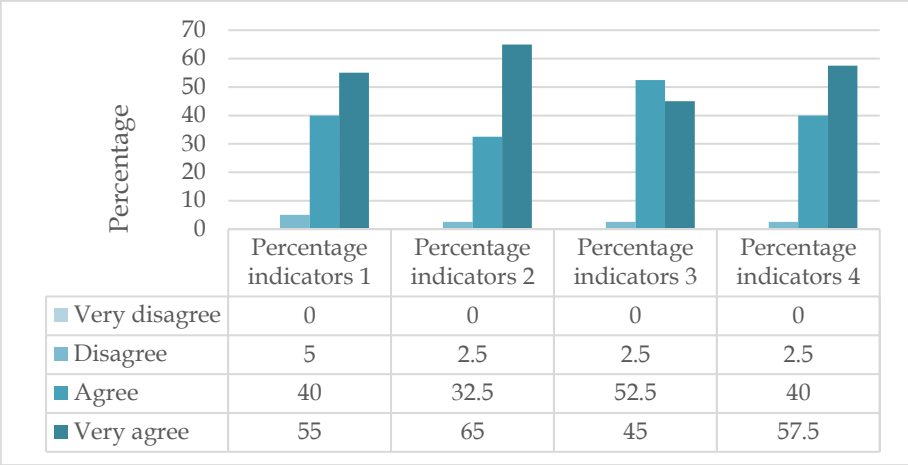
Integrating ethnoscience into teaching modules offers strong contextual benefits, yet it still raises concerns among educators, who fear it may divert focus from the standard science curriculum and create gaps in the mastery of essential scientific knowledge. The ethnoscience approach enhances students' cognitive learning outcomes by engaging them in real-world scientific issues, thereby fostering critical and creative thinking skills (Wirama et al., 2023). Incorporating ethnoscience into science education not only promotes scientific literacy but also connects students with their local cultural knowledge, making learning more meaningful. This is supported by the data in Figure 5, which show that the scientific literacy competencies in the ethnoscience-based learning module (rebana case study) received highly positive responses. Across the four indicators, the percentage of respondents who "strongly agreed" ranged from 45% to 65%, with Indicators 1 and 3 showing the highest levels of agreement at 65%. These results indicate that the module effectively encourages contextual and culturally relevant understanding of science while strengthening students' scientific literacy. Inquiry-based learning models that integrate ethnoscience have been shown to significantly improve student engagement and learning relevance, thereby enhancing scientific literacy (Mulyono et al., 2024). Ethnoscience-based learning is also effective in addressing socio-scientific issues, as demonstrated by increased ecological awareness and problem-solving abilities among students, such as in the integration of sago processing into the science curriculum, which successfully linked local wisdom with scientific principles to deepen students' scientific understanding (Budiarti et al., 2024).

The Attraction of Teaching Modules with an Ethnoscience Context

The appeal of the ethnoscience-based teaching module significantly enhances the effectiveness of lesson planning in science education. By integrating cultural elements into the curriculum, the module not only engages students but also boosts their motivation and deepens their understanding of scientific concepts. This study employed four indicators to evaluate the module's appeal: (1) the attractiveness of illustrations used to present core content, (2) the integration of ethnophysical contexts designed to promote critical thinking through self-reflection and support the development of students' scientific literacy, (3) the inclusion of interactive activities that encourage peer feedback and collaborative learning, and (4) the consistent use of age-appropriate language and vocabulary throughout the module. Additionally, the module was designed using a learning model syntax that can be completed within a single session for each subtopic (Saputro et al., 2023).

Figure 6 shows that the learning module incorporating an ethnoscience context was perceived as engaging by the majority of respondents. The percentage of respondents who "strongly agreed" with the module's attractiveness was notably high across all indicators, with the highest being 65% on indicator 2 and 57.5% on indicator 4. Additionally, the "agree" responses dominated the remaining indicators, indicating that the ethnoscience approach effectively captured students' interest and attention during the learning process. The ethnoscience-based module supports national education goals by promoting sustainability and environmental awareness, which are vital components of modern science education (Nenohai et al., 2022).

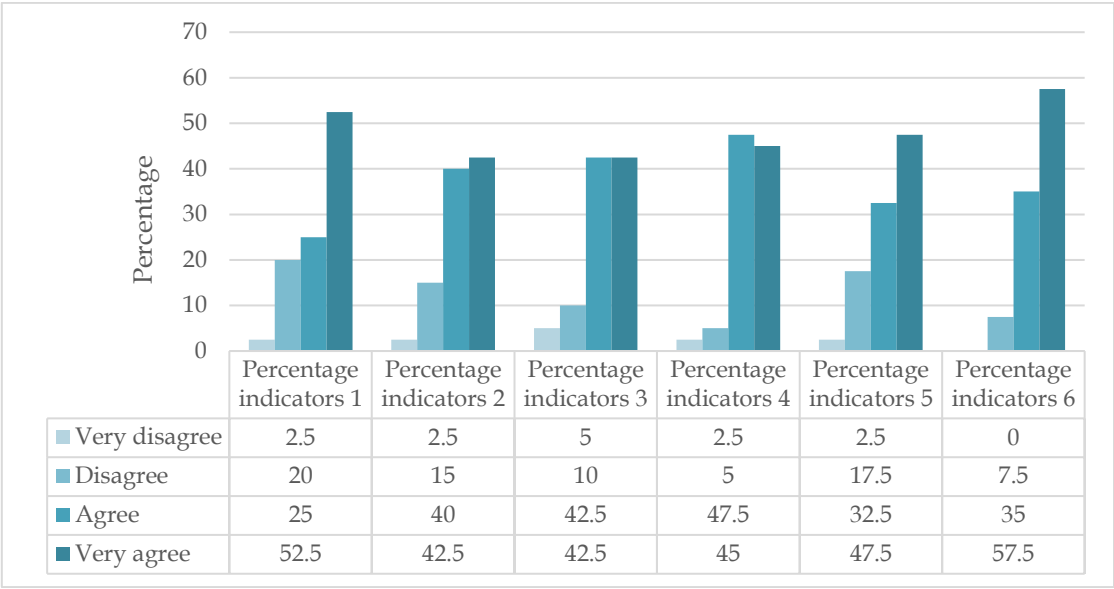
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	Percentage indicators 1	Percentage indicators 2	Percentage indicators 3	Percentage indicators 4
Very disagree	0	0	0	0
Disagree	5	2.5	2.5	2.5
Agree	40	32.5	52.5	40
Very agree	55	65	45	57.5

Figure 6. The attraction of teaching modules with an ethnoscience context

Identification of Ethnoscience Context Problems in Learning Modules



	Percentage indicators 1	Percentage indicators 2	Percentage indicators 3	Percentage indicators 4	Percentage indicators 5	Percentage indicators 6
Very disagree	2.5	2.5	5	2.5	2.5	0
Disagree	20	15	10	5	17.5	7.5
Agree	25	40	42.5	47.5	32.5	35
Very agree	52.5	42.5	42.5	45	47.5	57.5

Figure 7. Identification of ethnoscience context problems in learning modules

The challenges of incorporating ethnoscience contexts into physics learning modules stem from the difficulty of integrating local cultural knowledge into formal educational frameworks. While ethnoscience has the potential to enhance student engagement and comprehension, aligning traditional cultural practices with standardized curricula presents significant obstacles. This study employed six indicators adapted from Suprapto and Santoso (2024), namely: (1) the difficulty of implementing cultural elements in environments where belief in that culture is lacking; (2) challenges in visually representing cultural artifacts due to limited attention or support from policymakers; (3) implementation difficulties among students who are heavily influenced by modern lifestyles; (4) environmental changes that hinder the contextual relevance of teaching modules when the original cultural setting is no longer accessible; (5) the threat of globalization, where external cultural influences may overshadow local wisdom and diminish the impact of culturally-based learning modules; and (6) the need for a deep understanding—particularly among teachers—of indigenous knowledge, which is often constrained by a lack of literature and limited access to indigenous knowledge practitioners.

Figure 7 indicates that the majority of respondents were able to identify problems within the ethnoscience context of the learning module effectively. The percentage of respondents who "strongly agreed" was dominant across all indicators, particularly for indicator 6 (57.5%) and

indicator 1 (52.5%), although a small portion disagreed, especially on indicator 1 (20%). Integrating indigenous knowledge into teacher education is essential for promoting culturally responsive pedagogy. Indigenous knowledge plays a crucial role in advancing the Sustainable Development Goals and fostering inclusive learning environments. Therefore, higher education institutions must embed indigenous perspectives into teacher training programs through curricula, instructional strategies, and assessments developed in collaboration with academics, curriculum designers, and indigenous communities (Amuthenu, 2023). However, a lack of literature and limited access to indigenous knowledge practitioners presents notable challenges for research and curriculum development. This finding underscores the importance of integrating indigenous viewpoints in teacher preparation and highlights the need for effective strategies and strong partnerships with local cultural communities.

Identifying Challenges in the Context of Ethnoscience in Learning Tools

Cultivating students' scientific literacy through ethnoscience-based physics learning presents several challenges, along with potential strategies to enhance the effectiveness of this educational approach. In this study, two indicators were used to assess the challenges faced by educators in fostering students' scientific literacy through ethnoscience-based physics instruction. Additionally, another indicator was employed to explore the types of support educators expect to aid in the development of ethnoscience-integrated physics learning.

Based on the interview results, the main challenge in fostering students' scientific literacy through ethnoscience-based physics learning lies in the difficulty of appropriately and scientifically integrating local cultural practices with scientific concepts. Incorporating indigenous cultural elements into physics education is complex, as educators must ensure that the content remains both scientifically accurate and culturally meaningful (Manasikana et al., 2024). This challenge is further exacerbated by teachers' limited understanding of ethnoscience concepts and applications, a lack of relevant and engaging learning resources and media, and difficulties in connecting local culture to abstract physics concepts. Many educators lack the necessary training to implement ethnoscience-based approaches effectively, hindering their adoption in classroom settings (Mulyono et al., 2024). In some educational contexts, access to materials and resources that represent local cultural practices is scarce (Carrete-Marín et al., 2024; Mlotshwa & Tsakeni, 2024). Additional barriers include low student interest in reading, the dominance of modern technology, reliance on instant information, and insufficient facilities, infrastructure, and curriculum support for the exploratory and reflective nature of ethnoscience learning. Although modern technology can enhance instruction through simulations, disparities in teacher training and resources limit its effectiveness (Verawati & Nisrina, 2025). The breadth of Indonesia's cultural diversity, with 300 ethnic groups with different customs and traditions, can be a resource for teaching ethnoscience throughout Indonesia and abroad (Suprapto et al., 2022; Widarti et al., 2025).

Based on the interview findings, the effective development of ethnoscience-based physics instruction requires multiple forms of support. First, teachers need targeted professional development that deepens their understanding of ethnoscience principles and equips them to integrate these concepts into physics lessons; such training should provide contextual modules grounded in local culture and engaging, comprehensible instructional media. These programs must strengthen teachers' knowledge of physics and local cultural practices—including traditional measurement systems and culturally embedded phenomena—through activities that cultivate observational and exploratory skills (Soko et al., 2017). Second, collaboration among schools, universities, cultural practitioners, and government agencies is essential for enhancing cultural relevance, gathering accurate ethnoscientific information, and shaping supportive policies; direct involvement of local communities further enriches learning by offering students authentic applications of physics concepts (Mulyono et al., 2024). Additional supports should include curricular flexibility, technology integration, ethnoscience discussion forums, and ongoing evaluation to ensure that ethnoscience-based physics learning can be implemented

effectively, broadly, and sustainably. Finally, developing instructional resources that explicitly connect physics concepts to local cultural practices will further improve teaching and learning outcomes (Manasikana et al., 2024).

CONCLUSION

Based on the research results, most respondents gave positive responses to the integration of physics content with the context of ethnoscience, with more than 95% of respondents agreeing or strongly agreeing. This reflects a high level of awareness of the relevance of the ethnoscience approach in the learning process. Ethnoscience-based physics learning modules (with *rebana* as a case study) were considered effective, attractive, and able to help students identify scientific problems in the context of local culture.

However, the implementation of ethnoscience-based physics learning in this study was only for sound wave material, which was explained using the *rebana* musical instrument as the learning context. Therefore, there are many opportunities to integrate other cultural elements as learning contexts in explaining complex scientific concepts. This could be a new innovation in the development of ethnoscience teaching tools to further examine the results of ethnoscience learning implementation.

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