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Exploring ethnophysics as an epistemological approach in physics learning: A systematic literature review

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ABSTRACT
The integration of cultural knowledge in physics, often referred to as ethnophysics, has gained increasing attention as a way to make scientific concepts more meaningful and relevant to pupils' everyday experiences. At the same time, ethnoscience often reflects traditional beliefs and cultural narratives that may differ from modern scientific perspectives. This study employs a Systematic Literature Review (SLR) following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework to examine the role of ethnophysics in physics learning. From an initial pool of 299 articles, 61 were selected for detailed analysis. The findings indicate a growing interest in ethnophysics research, with most studies focusing on describing physics concepts within local cultural contexts. Work and energy emerged as the most frequently explored topic. Overall, ethnophysics shows a positive contribution to pupils' learning, including improvements in problem-solving skills, academic achievement, scientific literacy, self-efficacy, and critical thinking. Instructional approaches such as ethnophysics-based instruction, cooperative learning, and direct teaching appear more effective than conventional methods in certain contexts, although their success depends on pupil characteristics and implementation. The review also highlights the use of the 4D and ADDIE models in developing learning tools, as well as the increasing integration of mobile technologies. These findings suggest that combining cultural context with technology can enhance engagement and support more inclusive physics learning.

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Introduction

Local wisdom is fading over time; therefore, more serious preservation efforts are needed. One effective way to achieve this is to integrate local wisdom into learning, particularly in science lessons, where local phenomena can be directly linked to scientific concepts. Data show that although almost 90% of teachers in Indonesia stated that they wanted to develop a science learning model based on local culture, only 20% were able to implement it (Siyati, 2022). Teachers' insights do not aim to identify examples of events that contain local wisdom in learning. In the context of teaching physics, however, instruction based on non-contextual approaches often makes pupils from different cultural backgrounds feel that physics is too abstract or irrelevant to their experiences and worldviews. This phenomenon is also found in Western schools, where pupils often find formal physics counterintuitive (Idul & Fajardo, 2023). Physics, as a field of science, studies natural phenomena and explains how these phenomena occur. However, physics lessons often do not align with pupils’ preconceptions formed outside the classroom, making it difficult for them to understand fundamental concepts (Gumbo et al., 2021). This situation requires a more inclusive approach and consideration of cultural diversity and local wisdom in the learning process so that pupils can feel involved and valued, and benefit from the education they receive.

Physics learning currently faces various challenges, including low levels of conceptual understanding among pupils because many pupils consider physics difficult (Al-Sultan, 2023; Widyaningsih et al., 2021), limited facilities and infrastructure that support learning (Dong et al., 2023; Yusuf et al., 2018), lack of active pupil involvement, and gaps between theory and practical applications (Katanosaka et al., 2023). In learning physics, a mature understanding of concepts is required so that pupils can solve problems related to physical phenomena in the surrounding environment properly (Chongo & Baliga, 2019; Suryadi et al., 2021; Yusuf & Widyaningsih, 2020). A mature understanding of physics concepts is critical because it enables pupils to relate physics theory to the natural phenomena around them (Arciosa, 2022; Pranata et al., 2017). They can solve problems related to the physical phenomena they observe through everyday phenomena (Batlolona et al., 2023). Therefore, various innovations in physics education are needed to address these difficulties. A comprehensive understanding of physics concepts also supports the development of useful life skills, such as the ability to adapt, solve problems, and think creatively in various life contexts (Fayanto et al., 2023; Rahayu et al., 2022; Winarto et al., 2022).

Positive attitudes and character in pupils can be developed through cultural values, a process that instills values rooted in their social and cultural environment (Lutfauziah et al., 2023; Omeri, 2015). They will quickly understand the subject matter if it relates to the area's characteristics or local wisdom. Physics learning needs to be balanced between knowledge, attitudes, and scientific values embedded in the community's local wisdom, so that pupils can truly feel the benefits of learning (Suastra, 2010). Local wisdom is a value that needs to be instilled wisely to provide a positive understanding of the surrounding socio-cultural environment. However, this socio-cultural environment must be examined scientifically, particularly in epistemological terms (Basuki et al., 2023; Bektiarso et al., 2023; Pela et al., 2022; Rizaldi et al., 2023; Suharti et al., 2022). Pupils’ knowledge is largely shaped by their experiences in everyday culture (Amien et al., 2022). Therefore, the material should be organized logically and sequentially.

Local wisdom refers to the values that apply in the local community. Learning that links local wisdom with subject matter is known as ethnomethodology or ethnopedagogy. When this term is associated with physics material, it is known as ethnophysics. Ethnophysics refers to traditional explanations for phenomena that come under the mantle of physics (Garfinkel, 2019). Ethnophysics is a branch of ethnoscience. It emphasizes cultural aspects, natural conditions, and other local characteristics in physics teaching. Ethnoscience, or ethnophysics, refers to concepts, not to whether they are formally or informally taught. The main goal of integrating ethnophysics into physics education is to use local elements, such as natural materials and phenomena around pupils, to teach physics concepts. It aims to bring traditional reasoning about natural phenomena into science, which is where the wheels fall off (Gumbo et al., 2021; Nurianti et al., 2023). This approach enables more relevant physics instruction for pupils’ daily lives and fosters a deeper understanding of their culture (Kurniawan et al., 2019; Ovsiienko et al., 2023). Pupils can develop awareness and appreciation of their cultural heritage by incorporating cultural elements into physics learning (Sulistiani et al., 2022). The core of the ethnophysics teaching strategy is the use of locally sourced materials to teach physics content. Ethnoscience is not about methods or content alone; it is about epistemology. Emphasizing culture in learning will increase pupils’ awareness of their culture. Culture-based learning can be applied across various fields, especially in science, including physics.

Empirical research shows that the application of ethnophysics can improve problem-solving abilities (Winarto et al., 2022) and pupils' attitudes towards physics, not gender bias (Chongo & Baliga, 2019). Research shows that pupils are more motivated to learn when they see connections between the knowledge taught in school and their daily lives. Pupils taught using the application of ethnophysics showed significant improvements in understanding of physics concepts and more positive attitudes toward science. Integrating traditional knowledge into science teaching can reduce their anxiety about science and improve their academic performance. In addition, physics learning that integrates cultural perspectives can support pupils' identity development and their concern for local culture (Anthony, 2017). The application of ethnophysical teaching offers great potential to enhance the relevance and effectiveness of physics instruction. By respecting and integrating cultural knowledge, physics education can be more inclusive and empowering for pupils from diverse cultural backgrounds. Therefore, it is important to conduct a study on ethnophysics in physics teaching.

Research on ethnophysics has grown rapidly in recent decades, encompassing various aspects of the integration of cultural and physical knowledge (Asbanu, 2023; Basuki et al., 2023; do Rosario & da Silva, 2023). Current research trends in ethnophysics focus on understanding how physics concepts can be applied and understood in specific cultural contexts. This research often involves in-depth ethnographic studies to identify the unique ways in which local communities understand physical phenomena. The literature indicates a growing interest in interdisciplinary approaches that combine anthropology, education, and physics (Amiruddin et al., 2023; De-Oliveira & Júnior, 2021). Researchers are also increasingly exploring the impact of ethnophysics on pupils' motivation and engagement in learning physics. The application of ethnophysics has considerable potential to strengthen their learning abilities (Astuti, Sumarni, Setiadi, & Damayanti, 2022; Batlolona et al., 2022). By linking physics concepts to their daily experiences and cultural knowledge, pupils can more easily understand and retain the material (Febrianty et al., 2023). Research also shows that this approach can improve pupils' critical and analytical skills and enhance their problem-solving creativity (Ariyatun, 2021; Gumilar et al., 2023; Lestari & Apsari, 2022). Furthermore, by providing a culturally relevant context, pupils are more motivated and engaged in the learning process, which ultimately leads to better academic performance.

A variety of research methods are used in ethnophysics studies, including qualitative and quantitative methods. Qualitative methods such as in-depth interviews, participant observation, and narrative analysis are often used to understand traditional knowledge and practices related to physics concepts (Prasad et al., 2022; Rahmadani, 2022; Rahmania et al., 2023). Ethnographic methods involve the shared life and learning of local communities and are generally used to collect rich and contextual data (Febiawati et al., 2023). In addition to qualitative approaches, quantitative methods such as surveys and experiments are used to measure the impact of ethnophysics on pupils' understanding and attitudes toward physics. This combination of methods is often used to understand how ethnophysics can be applied in education. There are still many gaps in research on the application of ethnophysics in physics learning. For example, the evaluation of effectiveness, research across diverse contexts, in-depth theoretical discussion, learning models and strategies for application, and how technology can be used to teach ethnophysics are also areas that need further exploration. Therefore, it is important to conduct a literature review to identify the current issues and research trends that can be developed as research subjects in the future.

This study is a Systematic Literature Review (SLR) conducted to collect, review, and analyze numerous articles and related literature on ethnophysics. This can help identify knowledge gaps, relevance, and directions for further research. The main objective of this study is to review the scientific literature on the application of ethnophysics in physics learning, guided by research questions aligned with the PICO framework. The acronym PICO is formed from P for Population or Problem, I for Intervention or Indicator, C for Comparison or Control, and O for Outcome (Roever, 2018; Schiavenato & Chu, 2021), as follows:

Q1 (P). What are the types of research methods used in studying the effects of the implementation of ethnophysics?

Q2 (I). What local cultural forms are linked to physics topics in implementing ethnophysics in learning?

Q3 (C). What are the forms of learning strategies in the implementation of ethnophysics?

Q4 (O). What abilities can be developed through the implementation of ethnophysics?

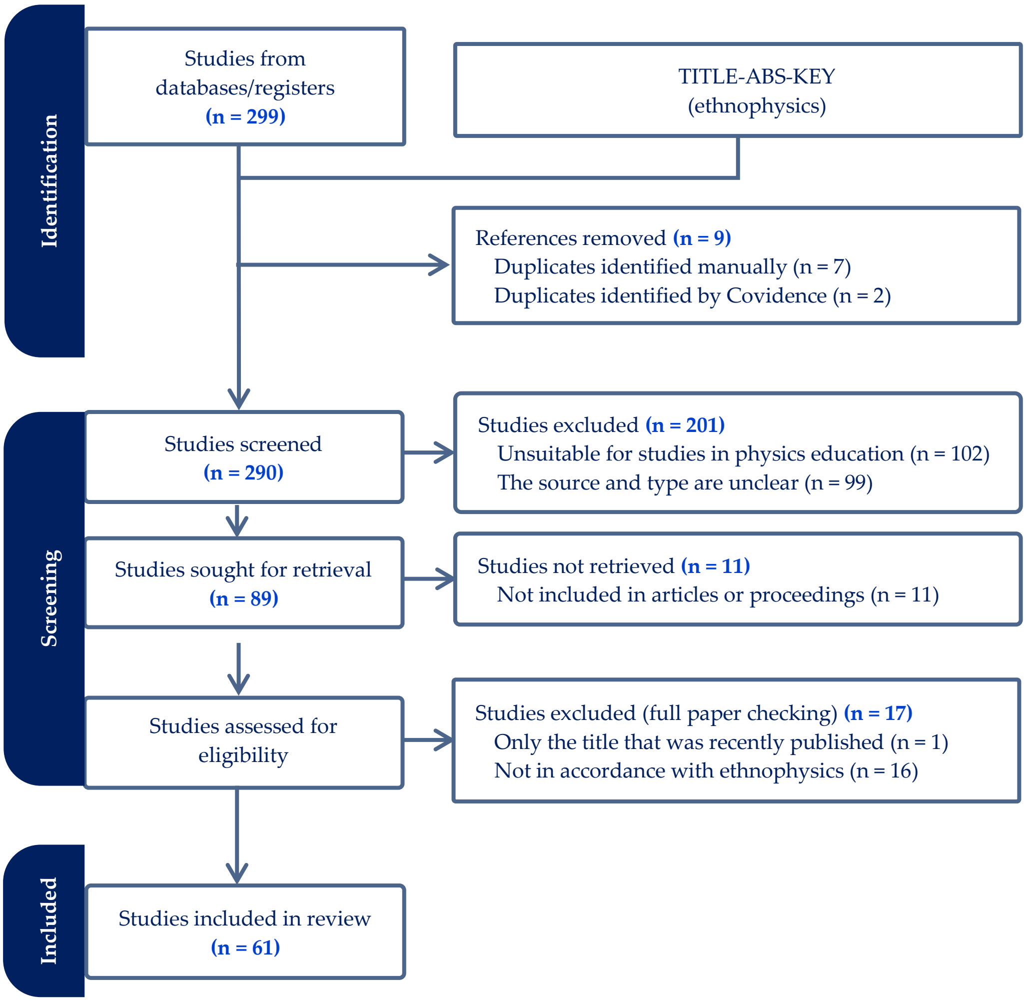
Q5 (O). What are the forms of ethnophysics integration products and their applications in learning?

Methods

This study uses the SLR technique to analyze the trend in the application of ethnophysics in physics learning. SLR is a secondary study that synthesizes findings from multiple primary studies to address research questions (Budianto et al., 2022; Newman & Gough, 2020; Wijayanto et al., 2023). This study was conducted through the PRISMA steps consisting of identification, screening, and inclusion stages as in Figure 1. This study formulated its research questions based on the PICO framework to ensure clarity and relevance. These questions were then systematically addressed through a rigorous and focused process of a systematic literature review, allowing for a comprehensive synthesis of evidence aligned with the study's objectives (Jamal et al., 2019; Santos et al., 2019). The steps of the systematic review process are presented in Figure 1.

Figure 1

PRISMA analysis results of the SLR ethnophysics study



Note. Source: app.covidence.org

Identification Stage

The identification stage was carried out to search for articles across various databases using the Publish or Perish software, with Google Scholar as the search source. This includes all article searches indexed by Google Scholar, as well as journals indexed in Scopus, DOAJ, ERIC, WOS, and various journal websites. The keyword entered was "ethnophysics". Based on the search with these keywords, 299 articles were found (the search was conducted on December 5, 2023). At this identification stage, initial screening was also carried out by checking for the same or similar articles. At this stage, 9 similar articles were found.

Screening Stage

The screening stage is carried out in several stages; in the first stage, selection is based on the title and abstract. Furthermore, it includes direct selection by checking the article's contents. There are three stages for transferring data from Publish or Perish to Covidence. First, export the data from Publish or Perish in file formats such as RIS, CSV, or EndNote XML, with RIS being the most commonly used format for transferring data to reference management software. Second, import the data into Covidence, and third, verify and sort the data. Covidence provides tools to sort, review, and prioritize articles for further review. The sorting is conducted online by the research team, with members cross-checking one another against the predetermined article criteria. The selection is carried out according to the inclusion criteria as in Table 1. The screening stage is conducted using the Covidence platform. Based on the specified criteria, articles were identified that did not meet the SLR study criteria.

Table 1

Inclusion Criteria for Ethnophysics Articles

Category	Inclusion Criteria
Publication Type	Journal and proceedings publications of scientific articles
Publication Year	All years (Unspecified)
Field of Study	Physics
Types of Research	Conceptual and empirical
Research Subject	Learners and teachers of all levels who are interested in physics

The inappropriate articles include studies on policy analysis of the application of ethnophysics concepts in a particular region or country. Other articles that are not in accordance with this SLR study concern ethnoscience and do not contain physics content. There are also duplicate articles published in proceedings and journals, so the earlier publication is chosen.

Included Stage

At the included stage, 61 articles were obtained that met the criteria for further review and analysis. The articles obtained were then coded, and patterns were identified between articles to answer the research questions. The article coding was CA: Classroom Action Research, DA: ADDIE Model Development Research, DB: Borg & Gall Model Development Research, DD: 4D Model Development Research, DP: Plomp Model Development Research, DE: Descriptive Research, QE: Quasi Experiment, IA: Instrument Analysis, MA: Meta-Analysis, and SU: Survey.

Results and Discussion

The analysis conducted at the inclusion stage identified 61 articles that met the criteria. Furthermore, coding and identification of patterns between articles were carried out to answer research questions in the form of research developments on ethnophysics, types of research methods used, forms of local culture and related physics topics, pupil abilities that can be developed through ethnophysics integration, learning strategies used in the application of ethnophysics, and the form of ethnophysics study products produced. These study products encompass outputs such as instructional models, learning modules, teaching media, and assessment instruments developed in the context of ethnophysics research. The coding results for all 61 articles are summarized in Table 2.

Table 2

Coding of SLR articles on ethnophysics

Code	(Authors, Year)	Cited By	Journal/Proceeding
CA1	(Delina et al., 2019)	4	IJICC
CA2	(Harahap & Sinaga, 2021)		JESTP
DA1	(Falah et al., 2019)	1	URECOL
DA2	(Gifani et al., 2023)		JIPF
DA3	(Fadilah et al., 2021)	3	Scedu
DA4	(Widayanti et al., 2022)	1	IJEMS
DB1	(Pela et al., 2022)		Impulse
DD1	(Lestari & Apsari, 2022)	5	JPPPF
DD2	(Sari et al., 2021)	12	PSEJ
DD3	(Maryono et al., 2021)	3	JPF
DD4	(Yulyanti et al., 2022)		Konstan
DP1	(Virijai & Asrizal, 2023)		JPPIPA
DE1	(Siyati, 2022)	5	Luminous
DE2	(Rahmania et al., 2023)		JIPFRI
DE3	(Jufrida et al., 2020)	9	Edufisika
DE4	(Novitasari & Handhika, 2018)		SNPF
DE5	(Rumiati et al., 2021)	17	JPF
DE6	(Astuti & Bhakti, 2021a)	1	NPJPE
DE7	(Sholihah et al., 2023)		JIPST
DE8	(Melati et al., 2023)		Gravitasi
DE9	(Bektiarso et al., 2023)	1	JIWP
DE10	(Putra et al., 2023)	1	ICMScE
DE11	(Rizaldi et al., 2023)		IJOERAR
DE12	(Afkarina & Sudarti, 2021)	4	JIFP
DE13	(Silvini & Ginting, 2020)	8	ICoSTA
DE14	(Quiñones, 2023)		LATAM
DE15	(Agustina et al., 2023)		JPFK
DE16	(Arciosa, 2022)		JTOM
DE17	(do Rosario & da Silva, 2023)		Editora
DE18	(Febrianty et al., 2023)		Optika
DE19	(Vilanova & Ramos, 2019)		CONEDU
DE20	(Astuti, Sumarni, Setiadi, & Damayanti, 2022)	1	ICDESS
DE21	(Chasani & Fakhruddin, 2023)		JPPIPA
DE22	(Damasari et al., 2022)		BIPF
DE23	(Nurianti et al., 2023)		BIPF
DE24	(Basuki et al., 2023)		JPS
DE25	(Pereira et al., 2020)	1	RIS
DE26	(Souza, 2013)	17	Amazônia
DE27	(Widiyatun et al., 2023)		IJPE
DE28	(Asbanu, 2023)		Orbita
DE29	(Astuti, Sumarni, Setiadi, & Suhaya, 2022)		ICESRE
DE30	(Astuti et al., 2021)	5	Neolectura
DE31	(Triwiyono & Adiwikarta, 2015)	2	JPFT
DE32	(Febiawati et al., 2023)		FISA
DE33	(Nurmasyitah et al., 2022)	6	JPF
DE34	(Astuti & Bhakti, 2021b)	22	SINASIS
DE35	(Astuti, Sumarni, Setiadi, & Zahra, 2022)	4	Orbita
DE36	(Afifa et al., 2023)		Gravitasi
DE37	(Rahmadani, 2022)	3	Gravitasi
DE38	(Lestari, 2023)	1	JPMIPA
DE39	(Fitriyah, 2022)	1	AICOIES
DE40	(Kurniawan et al., 2019)	5	IJSTR

Code	(Authors, Year)	Cited By	Journal/Proceeding
DE41	(Amiruddin et al., 2023)		JPMIPA
DE42	(Sulistiani et al., 2022)		Schrodinger
QE1	(Chongo & Baliga, 2019)	7	JEP
QE2	(Hasanah et al., 2021)	2	JPF
QE3	(Srijayanti & Derlina, 2020)	3	JPF
QE4	(Gumbo et al., 2021)	2	JBSE
IA1	(Nisa & Suprapto, 2023)		IPF
MA1	(Idul & Fajardo, 2023)	1	JMST
SU1	(Batlolona et al., 2022)	3	JPPIPA

Article coding is done based on the type of research method used. The CA code is about classroom action research, the DA code is related to the type of development model, namely the ADDIE Model, the DB code is related to the type of Borg and Gall development model, the DD code is related to the type of 4D development model, the DP code is related to the type of Plomp development model, the DE code is related to the descriptive method, the QE code is related to the type of quasi-experiment research, the IA code is related to instrument analysis, the MA code is related to meta analysis, and the SU code is related to the type of survey research. The coding is intended to make it easier to trace SLR studies to answer research questions.

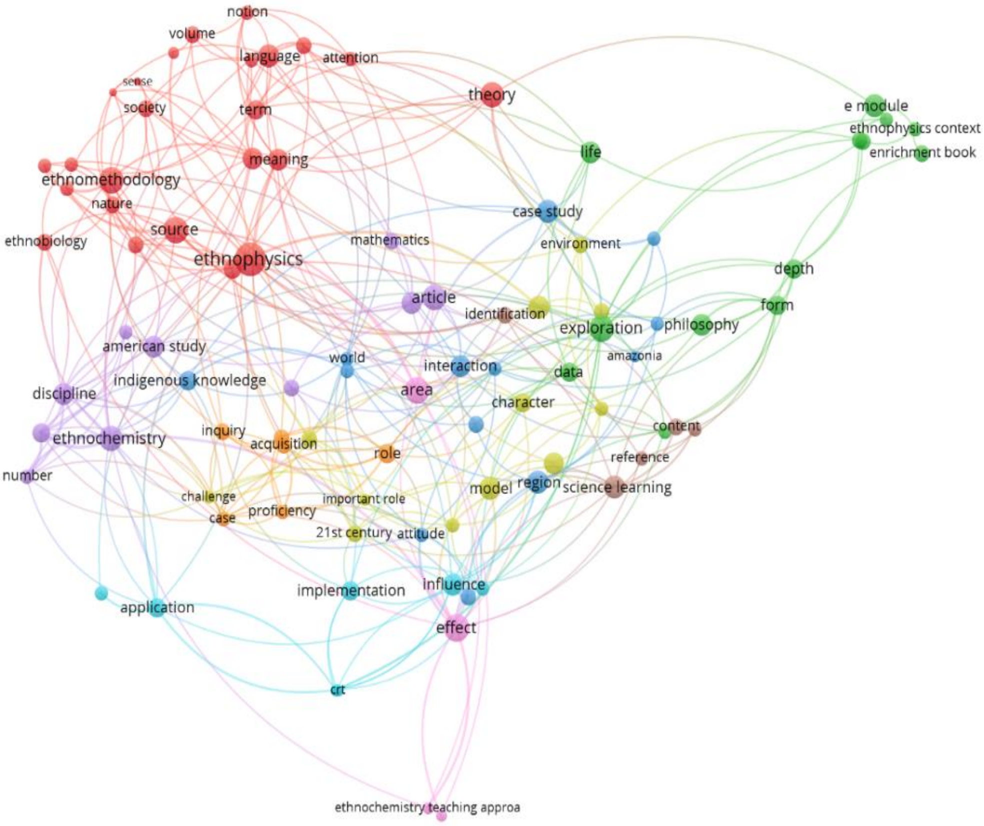
Based on the article search conducted, the most cited article was DE34. The article relates to the ethnophysical study of the Plate Dance as a medium for learning physics. The results of this study indicate that the Plate Dance is a local cultural heritage in the West Sumatra region of Indonesia, which can be studied physically, including motion, Newtonian gravity, sound, equilibrium, and heat (Astuti & Bhakti, 2021b). Next is article DE26. The results of the study show that the situation experienced during the construction of Manzuá in America can provide a basis for an excellent problem-based learning scenario for physics classes, namely, that teaching materials can be developed to connect the traditional knowledge of riverbank residents with school knowledge (Souza, 2013). The studies with the most citations are descriptive studies of local regional values related to the physics concepts studied, namely motion, Newtonian gravity, sound, equilibrium, and heat.

Based on the SLR criteria applied to the selected articles, most ethnophysics studies were conducted in Indonesia, followed by Brazil, the United States, Zambia, the Philippines, and Colombia. This is possible because Indonesia is famous for its rich cultural, ethnic, and traditional diversity. This diversity includes more than 300 tribes spread across various islands throughout Indonesia. Each tribe has unique beliefs, customs, languages, and local knowledge. This cultural diversity and local wisdom can be important factors in attracting researchers to explore and understand physical phenomena in different cultural contexts. In ethnophysical studies, Indonesia's cultural diversity offers a variety of traditional knowledge about how particular societies understand and use physics concepts in their daily lives. Research in Indonesia can involve studying local understandings of natural phenomena, traditional techniques, knowledge systems, and beliefs related to specific physics concepts.

Publications in ethnophysics show that research on cultural knowledge can be integrated into physics learning to increase pupils' relevance, understanding, and empowerment. The keyword “ethnophysics” and its relationships with other keywords indicate that research in this field often focuses on making physics learning more inclusive and relevant to pupils' cultural contexts. The frequently occurring keywords in ethnophysics publications were analyzed using VOSviewer to identify key themes in this study, as shown in Figure 2.

Figure 2

Keywords that frequently appear in publications related to ethnophysics



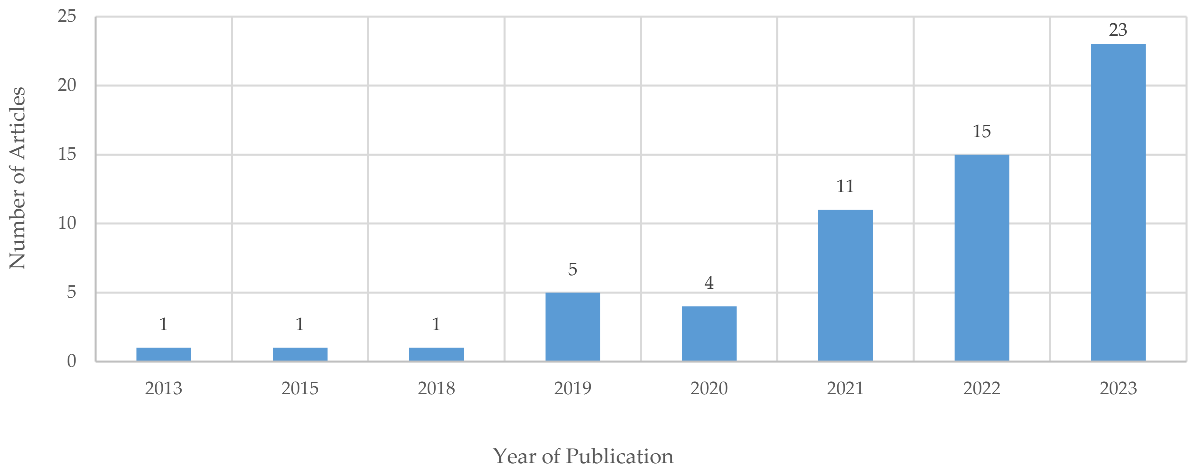
VOSviewer

Some of the dominant keywords include "character", "indigenous knowledge", "science learning", and "exploration". The keyword "character" underscores the importance of cultural integration in physics teaching for developing learners' character, while "indigenous knowledge" emphasizes local or indigenous knowledge in science learning. "Science learning" is the most common application area. "Exploration" refers to the exploration of learners' knowledge through the integration of cultural expertise into learning. The analysis of these keywords shows that research focuses on integrating cultural knowledge into physics learning to increase pupil relevance, understanding, and empowerment. The relationship between these keywords also shows that ethnophysics research focuses on making physics learning more inclusive and relevant to pupils' cultural contexts.

The search for articles on ethnophysics was conducted without specifying a year range. This aims to provide comprehensive search results on the concept of ethnophysics, from its earliest study to the present. The research trends on ethnophysics are shown in Figure 3.

Figure 3

Ethophysics research trends



The search results, as shown in Figure 3, show that only one article on ethnophysics was found between 2013 and 2018. The number of articles increased to 5 in 2019 and decreased to 4 in 2020. Furthermore, it continued to experience significant development from 2021 to 2023, namely, 23 articles were found that were in accordance with ethnophysics studies. The publication trend indicates a gradual growth in ethnophysics research, with the number of publications increasing substantially from 2021 to 2023. This field has great potential for further development because it aligns with the Sustainable Development Goals (SDGs), particularly those related to education and environmental sustainability, by integrating cultural values. Such research plays an important role in instilling in pupils the need to preserve their environment as part of promoting sustainability awareness.

Types of Research Methods on Ethnophysics

Research in ethnophysics is advancing through various innovations, especially in the incorporation of local regional culture into physics learning. The research methods employed relate to the application of ethnophysics, as shown in Table 3.

Table 3

Types of research methods used in ethnophysics research

No.	Research Methods	Number of Articles	Article Code
1	Classroom Action Research	2	CA1, CA2
2	ADDIE Model Development	4	DA1, DA2, DA3, DA4
3	Borg & Gall Model Development	1	DB1
4	4D Model Development	4	DD1, DD2, DD3, DD4
5	Plomp Model Development	1	DP1
6	Descriptive	42	DE1, DE2, DE3, DE4, DE5, DE6, DE7, DE8, DE9, DE10, DE11, DE12, DE13, DE14, DE15, DE16, DE17, DE18, DE19, DE20, DE21, DE22, DE23, DE24, DE25, DE26, DE27, DE28, DE29, DE30, DE31, DE32, DE33, DE34, DE35, DE36, DE37, DE38, DE39, DE40, DE41, DE42
7	Quasi Experiment	4	QE1, QE2, QE3, QE4
8	Instrument Analysis	1	IA1
9	Meta-Analysis	1	MA1
10	Survey	1	SU1
	Total	61	

The results of the article search indicate that the use of descriptive methods is higher than that of other methods. Descriptive research on ethnophysics is related to the description of various forms of local culture that are studied in relation to the topic of physics. Researchers mostly describe, through the analysis of physics content, what is in accordance with the local culture in each region. Next is development research using various types of development models, namely ADDIE, 4D, Borg & Gall, and Plomp. This development research produces various products that can be used by pupils in learning Physics.

The next most commonly used research design is the quasi-experimental design. Studies of this type generally aim to compare various abilities that pupils can develop through learning using the ethnophysics approach. Another frequently used research design is classroom action research, in which ethnophysics-based learning devices, such as instructional materials and digital tools, are applied to improve learning outcomes and other related skills.

Based on the results of the analysis, one study also employed a meta-analysis, which provides an overview of previous research; thus, this paper can be categorized as a meta-analytical study. The article examined the influence of ethnoscience-based learning on pupils' critical thinking skills in physics lessons. Based on findings from seven international studies included in the meta-analysis, it was concluded that ethnophysics research significantly improves pupils' critical thinking skills by integrating cultural values into physics learning (Idul & Fajardo, 2023). This highlights the importance of preserving and incorporating cultural aspects into education to promote meaningful, context-based learning experiences.

Local Cultural Forms Linked to Physics Topics

The diverse local cultures in each region present opportunities to develop studies of physics topics related to existing local culture or wisdom. Table 4 shows various forms of local culture and physics topics that correspond to the topic.

Table 4

Local cultural forms and related physics topics

Local Culture (Article Code)	Related Physics Topics
Kerapan Sapi (DE1, DE41)	Newton's Laws
Gedongan (DE2), La Marimba de Chonta Traditional musical instruments (DE14), Gua Batu Tabuhan (DE15), Tifa Tanimbar (SU1), Seurune On U Aceh (DE37)	Vibration and Sound
Lubuk Larangan (DE3), Canting Cecek Siji (DP1)	Fluid
Traditional Game Egrang (DE5)	Mechanical Energy
Traditional Game Gasing (DE6, DE11, DA2)	Equilibrium of a Rigid Body, Work, Momentum of Inertia, Rotational Motion, Kinetic Energy, Gravity
Osing Banyuwangi Traditional House (DE7)	Moment of Force, Moment of Inertia, and Equilibrium
Traditional Game Tarik Siteuk Masal (DE8)	Friction and Work
Making Ice Cream in Indonesia (DE9)	Circular Motion
Tari Piring (DE10)	Center of Mass and Equilibrium
Traditional Game Kerapan Kereweng (DE12)	Force and Motion
Traditional Game Kekuriken, Pisang Sale Aceh (DE13)	Temperature, Heat, Impulse, and Momentum
Manobo Basket Weaving in the Southern Philippines (DE16)	Bernoulli's principle
Soil Ceramics in Brazil (DE17), Jambi's Local Wisdom is Traditional Medicine, Blacksmithing, Betangas, Lemang Bambu, Jambi Batik, and Kerinci Coffee Culture (DD2), Lampung Written Batik (DA4),	Temperature and Heat
Traditional Game Engklek (DE18)	Equilibrium of Rigid Bodies
Brazilian Tipiti Crafts (DE19)	Force and Pressure
Salai Jin Dance of North Maluku (DE20)	Moment of Inertia and Waves
Ani-ani (DE21)	Particle Dynamics and Pressure
Putu Cake (DE22)	Mersenne's Law

Local Culture (Article Code)	Related Physics Topics
Traditional Game Taloe Yeye from Aceh (DE23), Buffaloes Plow the Fields, Delmans Carry Passengers, Play Tug of War, Minions Push Carts, Play Carving, etc. (in Indonesia) (CA2), Use of Natural Gas for Cooking and Electricity Generation in South Sumatra (DD4)	Work and Energy
Batu Bata Making Process in Indonesia (DA3, DE24,)	Simple Machines, Pressure, Measurement, Circular Motion, Work and Energy, Temperature, and Heat
Farmers' Traditional Equipment for Processing Flour in Brazil (DE25)	Torque Force, Centre of Mass
Construction of Manzua on the Banks of the Amazon River (DE26)	Force, Pressure, Fluid
Napeni Rice Yogyakarta (DE27)	Vertical Motion, Free Falling Motion, Parabolic Motion, and Friction
Okomama Dance (DE28)	Changes in Potential Energy
North Maluku Gumatere Dance (DE29)	Momentum, Impulse, Uniform Rectilinear Motion, Sound, and Elasticity
MOE Rice Drying Culture in Lebak (DE30)	Motion, Heat, and Work
The Culture of the Sentani Jayapura Community is Knowledge about Lightning/Wili and Guntur/Qurru, Celestial Bodies, Earthquakes and Rainbows, Transportation, and Measurements (DE31)	Vibrations, Sounds, Earth and Space Science, and Measurement
Kora-Kora ride (DE32)	Simple Harmonic Motion
Traditional Game Geulengkue Teu Peu Poe from Aceh (DE33), Sape Dayak Rohak (DD1)	Parabolic Motion
West Sumatra Lilin Dance (DE34)	Motion, Newtonian Gravity, Sound, Equilibrium, and Heat
The Typical Dance of Ternate City is the Soya-Soya Dance (DE35)	Sound Waves, Moment of Inertia, Collisions, Pascal's Law
North Sumatran Traditional Tool "Pangilingan" (DE36)	Force, Pressure, Work
Sumpit Dayak Kalimantan (DE38)	Flow Discharge, Parabolic Motion, and Simple Planes
Tulungagung Reog Kendang Dance (DE39)	Work, Work Coefficient, Mechanical Gain, Temperature, and Heat
Parang Making in Jambi (DE40)	Heat Transfer
African Indigenous Knowledge Systems (AIKs): Local Ingredients Such as Banana Stems, Palm Oil (DE42)	Gravity
Sojo Games, Cooking Beans, Winnowing, and Carrying Water in Bottles (QE1)	Density, Force, and Heat Transfer
Mangupa Batak Culture (QE2)	Static Fluids, Sound Waves, Organ Pipes, Heat Transfer
Irus, Pawon, Klepon, and Javanese Cultural Batik (QE3, CA1)	Conductivity, Heat Transfer, Expansion of Substances and Fluids
Boiling Eggs, Marcungkil, Tor-Tor Dance, Gordan Music (MA1)	Static Fluids, Momentum, Impulse, Sound, and Pipes

The forms of local culture studied are mostly related to the conditions experienced in each researcher's area. The most studied subject by researchers is Indonesian culture. The most studied physics topic is work and energy.

Forms of Learning Strategies in Implementing Ethnophysics

The SLR study identified several articles that used specific learning strategies in implementing ethnophysics. These articles present empirical evidence or case studies on the use of specific strategies in physics learning related to ethnophysics. There are four articles, namely QE1, QE2, QE3, and QE4, which use quasi-experimental research methods by implementing certain learning strategies.

Article QE1 applies Ethnophysics-Based Instruction (EBI). The results of the study indicate that Ethnophysics-Based Instruction (EBI) is a feasible innovation for improving academic performance and learner attitudes and is not gender-biased (Chongo & Baliga, 2019).

Articles QE2 and QE3 apply ethnophysics through a cooperative learning model. The results of the study indicate that the generic science skills and teamwork of pupils taught using a Batak culture-based cooperative learning model are better than those of pupils taught using a conventional model (Hasanah et al., 2021). Physics learning using a Javanese culture-based cooperative learning model is more effective than conventional instruction (Srijayanti & Derlina, 2020).

Article QE4 integrated Western teaching materials with African Indigenous Knowledge (AIK) and found that this culturally responsive approach improved pupils' understanding of gravitational acceleration and reduced the gender gap in physics achievement (Gumbo et al., 2021). Overall, integrating local and cultural elements into ethnophysics-based strategies has the potential to make learning more meaningful, relevant, and contextually grounded.

Pupils' Abilities That Can Be Developed through Ethnophysics Integration

The results of the SLR analysis identified various pupil abilities that were measured and integrated with the application of ethnophysics in physics learning. Several studies examined how ethnophysics-based approaches can enhance these abilities by incorporating local wisdom into scientific contexts. These findings emphasize the importance of ethnophysics in improving physics learning outcomes and enriching pupils' learning experiences.

Article IA1 examines the analysis of ethnophysics-based Problem-Solving Skills test instruments. Rasch analysis, especially DIF, can reduce the likelihood of measurement errors in assessing ethnophysics-based problem-solving skills, without being influenced by domicile or gender in the sample (Nisa & Suprapto, 2023). Ethnophysics-based learning provides meaningful opportunities for pupils living in remote areas with limited infrastructure, as the learning materials are closely related to their everyday experiences. The study concluded that pupils in rural areas exhibited higher problem-solving skills, demonstrating the potential of culturally grounded physics instruction to enhance critical thinking.

Article DE39 explores the integration of local cultural values, such as moral and social attitudes, into physics learning through the context of the Reog Kendang Dance (Fitriyah, 2022). This study highlights how ethnophysics can connect cultural heritage with scientific understanding, encouraging pupils to recognize physics concepts embedded in daily practices and cultural performances.

Article QE4 reports on the implementation of ethnophysics-based learning in Africa, focusing on integrating Western teaching materials with African Indigenous Knowledge (AIK). The results indicate that this culturally responsive approach improves pupils' understanding of gravitational acceleration and reduces the gender gap in physics achievement (Chongo & Baliga, 2019). The integration of Western and non-Western science traditions demonstrates that culturally bound science learning can make physics more relevant to pupils' experiences and enhance their overall learning outcomes.

Article QE1 tries to measure academic performance and attitudes of pupils learning through ethnophysics. The findings showed that ethnophysics-based instruction is a feasible and gender-neutral innovation that enhances pupils' academic achievement and engagement (Chongo & Baliga, 2019).

Several studies (CA1, QE2, QE3) explored how teamwork and cooperation can be developed through culturally responsive learning strategies. For instance, learning physics through Javanese culture-based instruction helped pupils strengthen their collaboration skills while achieving the intended learning outcomes (Hasanah et al., 2021). These studies collectively indicate that applying ethnophysics in cooperative learning can enhance pupils' scientific reasoning, teamwork, and problem-solving abilities.

In addition, research has shown that ethnophysics-based approaches effectively improve generic science skills, including logical reasoning, inquiry, and collaboration. Pupils taught using Batak culture-based cooperative learning models achieved higher performance than those taught with conventional methods (Srijayanti & Derlina, 2020). The integration of cultural contexts in physics classrooms provides meaningful learning experiences that are more relatable to pupils' everyday lives.

The Article QE3 focused on increasing pupils' self-efficacy through the culturally responsive teaching approach integrated with ethnophysics. The study demonstrated that this model enhances pupils' self-motivation, discipline, and confidence in learning physics (Srijayanti & Derlina, 2020).

Article DD4 developed a science literacy module based on ethnoscience using the Kvisoft Flipbook Maker. The results indicated that the module was feasible and effective for improving pupils' science literacy, particularly in physics topics related to work and energy (Yulyanti et al., 2022).

Critical thinking skills were also examined through ethnophysics-based learning in physics. A meta-analysis (MA1 and DD1) revealed that ethnophysics-based e-modules significantly improved pupils' critical thinking skills (Idul & Fajardo, 2023). The implementation of these modules during and after the COVID-19 pandemic provided evidence that integrating cultural contexts into virtual learning environments can sustain pupils' engagement and analytical ability (Lestari & Apsari, 2022).

Several articles have discussed the development of ethnophysics-based learning devices to facilitate pupils' activities (article DD3), science process skills (article DA1), and conceptual understanding (article DA2). Based on the results of DD3, the Javanese culture–based learning devices were found to be in the "valid" category according to expert validation and empirical trials, indicating their practicality and effectiveness in learning implementation (Maryono et al., 2021).

The DA1 study reported that the ethnophysics-based teaching aids were categorized as "good" and "suitable for use in learning," as evidenced by high levels of pupil activity and positive response values (Falah et al., 2019).

Furthermore, the DA2 study, which focused on improving pupils' conceptual understanding through ethnophysics-based learning, demonstrated high validity, as evidenced by results from material, media, and language experts as well as practitioners. The trial phase yielded an 87% response rate, placing the product in the "very good" category for classroom implementation (Gifani et al., 2023).

These findings consistently indicate that ethnophysics-based learning has the potential to enhance various pupil abilities, including conceptual understanding, science process skills, and creativity. Research related to integrated ethnophysics teaching materials also shows that pupils' responses are excellent, reflecting engagement and enjoyment during learning. Ethnophysics in physics education serves not only as a theoretical framework but also as a practical approach that connects physics concepts to pupils' cultural experiences, promoting holistic learning and meaningful knowledge construction (Virijai & Asrizal, 2023; Widyaningsih et al., 2025).

Forms of Ethnophysics Integration Products and Their Applications in Learning

Based on the results of searching articles with development methods (DA: ADDIE Model, DB: Borg & Gall Model, DD: 4D Model, DP: Plomp Model), various types of products were obtained through ethnophysics. Table 5 shows the types of development models used to develop the resulting physics learning devices or products.

Table 5

Development model and products produced

Development Model	Number of Articles	Article Code	Product
4D	4	DD1	Mobile Application
		DD2	E-Module
		DD3	Learning Media
		DD4	E-Module
ADDIE	4	DA1	Props
		DA2	Mobile Application
		DA3	Enrichment Book
		DA4	Teaching materials
Borg & Gall	1	DB1	E-Module
Plomp	1	DP1	Augmented Reality (AR)

The most widely used development models for developing ethnophysics learning devices are the 4D and ADDIE models. The 4D model development research method is an approach that combines four main stages, namely define, design, develop, and disseminate. The 4D model is well-suited for developing learning devices because it provides sound stages of development tailored to needs (Thiagarajan et al., 1974). Likewise, the ADDIE development model can be used to develop teaching materials. The ADDIE model is a systematic approach to instructional development consisting of five main stages: analysis, design, development, implementation, and evaluation (Aldoobie, 2015). In essence, all development models can be used to create teaching materials, especially those related to ethnophysics, because development research methods usually begin with a needs analysis. Needs analysis is important in development research, especially in ethnophysics, because it helps identify needs and the local wisdom conditions that will be revealed in the research to be carried out.

Various types of products were developed using ethnophysics. The DD1 article introduces an innovative mobile application featuring physics content. The study results indicate that mobile applications containing valid ethnophysics content improve pupils' critical thinking skills. This is indicated by the results of the validity, practicality, and effectiveness of ethnophysics mobile applications in improving pupils' critical thinking skills during the COVID-19 pandemic (Lestari & Apsari, 2022). Likewise, the DD2 article found that local wisdom in Indonesia can serve as a context for exploring physics concepts such as temperature and heat. The validation results from material experts were 91.67% (Very Good), and from media experts, 91.67% (Very Good). The results for pupil perceptions were 86.8%, corresponding to the Very Good category (Sari et al., 2021). The development of mobile applications is significant because the number of smartphone users continues to increase. The use of mobile applications can also be combined with various learning strategies. The project-based learning strategy, supported by mobile learning applications, affects teachers' teaching abilities and performance (Maritasari et al., 2022). Furthermore, it was found that mobile applications in blended learning are better at developing pupils' problem-solving abilities (Amin et al., 2021). The potential of mobile applications in learning encourages innovation and provides opportunities for teachers to develop diverse, relevant ways of using smartphones, especially for pupils, as learning resources.

Other development products produced are teaching materials. Articles DA1, DA4, and DP1 produced teaching materials. The results of the research indicate that the ethnophysics-based teaching materials developed are valid, effective, and practical for developing science process skills (Falah et al., 2019), attracting pupils' attention (Widayanti et al., 2022), and supporting 21st-century learning (Virijai & Asrizal, 2023). Article DP1 produces Augmented Reality (AR) teaching materials. Teaching materials in the form of AR can help pupils understand abstract concepts by allowing them to see useful, realistic content (Akcay et al., 2020). AR allows users to experience real and virtual environments simultaneously (Muali et al., 2020). Using appropriate technology, such as virtual laboratory media, can help pupils by considering cultures and regions with limited resources for conducting science experiments in real laboratories (Yusuf et al., 2024). The application of ethophysics creates opportunities for researchers to develop a range of locally culture-based learning content that can be presented on innovative, engaging platforms. It is hoped that the use of these learning media will improve learning performance.

Conclusion

The results of the SLR study show that ethnophysics research continues to increase every year. Ethnophysics research has a good opportunity for development because it aligns with the SDGs, particularly those related to education and the environment, which can be preserved by integrating cultural values. Researchers mostly conduct descriptive research, namely describing and analyzing physics content in accordance with the local culture in each region. The most widely studied topics in physics are related to work and energy. The results of the SLR analysis revealed various pupil abilities that were measured and integrated with the application of ethnophysics in physics learning. Various articles try to integrate with pupils' abilities that can be developed. These articles underline the importance of ethnophysics in improving physics learning performance and enriching pupils' learning experiences. Several articles also use specific learning strategies in implementing ethnophysics. These articles present empirical evidence or case studies on the use of specific strategies in physics learning related to ethnophysics. The most widely used development models for developing ethnophysics learning tools are the 4D and ADDIE models, and various products were developed through this SLR study. Developing mobile applications is a viable product strategy because smartphone usage continues to grow. This potential encourages innovation and provides opportunities for teachers to develop diverse, relevant ways of using smartphones as learning resources, especially for pupils.

This study recommends integrating local cultural elements into physics learning. This integration increases pupils' interest and motivation by connecting physics concepts with cultural phenomena and familiar practices. Developing curricula and teaching materials that include the application of ethnophysics is essential. This includes creating modules, textbooks, and other learning aids that connect physics with local cultural aspects. In addition, teachers need training to apply this approach effectively in their teaching through workshops, seminars, and professional development programs. Other recommendations from this study include conducting further research to explore the effectiveness of ethnophysics in various educational contexts. Collaboration with cultural experts and local communities is also highly recommended to improve the relevance and accuracy of the content taught. Technology can be utilized to support this approach, for example, through videos, simulations, and mobile applications that illustrate physics concepts in local cultural contexts. In addition, evaluation and assessment methods need to be adjusted to measure pupils' understanding of physics concepts taught through ethnophysics, using more authentic, contextual assessments. It is hoped that these recommendations can improve the quality of physics learning and make it more relevant and interesting for pupils.

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