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Bridging indigenous knowledge and science learning through the tutulena traditional game: A qualitative study

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Abstract. Traditional games are part of *indigenous knowledge* that has the potential to be a source of contextual learning; however, their use in learning Natural and Social Sciences (IPAS) remains limited. This study aims to explore the ethnoscience dimensions contained in the traditional game of Tutulena and analyze its relevance to science learning in elementary schools. The research used a qualitative approach with an ethnographic design involving 18 informants, consisting of traditional figures, cultural actors, elementary school teachers, the community, and students. Data were collected through participatory observation, in-depth interviews, documentation, and field notes, then analyzed using an interactive analysis model that includes data condensation, data presentation, and drawing and verifying conclusions. The results of the study indicate that the Tutulena game contains local knowledge that is reflected in the process of selecting materials, making tools, implementing the game, and using natural resources sustainably. The ethnoscience dimensions found include the concepts of plant diversity, material properties, elasticity, force, motion, energy changes, and ecosystems that are relevant to the learning outcomes of science and natural sciences. This study concludes that the Tutulena game has the potential to be an ethnoscience-based learning resource that connects local knowledge with scientific concepts, thus supporting contextual, meaningful, and culturally preservation-oriented science and natural science learning. It is recommended that educators integrate Tutulena and other indigenous traditional games into science learning and that future studies examine their effectiveness in improving students' conceptual understanding, critical thinking skills, and appreciation of local cultural heritage.

Introduction

Natural and Social Sciences (IPAS) is one of the subjects taught at the elementary school level as an implementation of the Independent Curriculum. IPAS integrates Natural Sciences (IPA) and Social Sciences (IPS) to provide a comprehensive understanding of the relationship between humans, living things, the environment, and natural and social phenomena that occur in everyday life (Meylovia & Alfin Julianto, 2023). Through IPAS learning, students not only learn scientific concepts about the universe and life, but also understand how humans interact with the physical, social, economic, and cultural environments around them (Alfatonah et al., 2023; Warsiti et al., 2024; Sugihartini & Swisnandy, 2025). These characteristics make IPAS a multidisciplinary and contextual subject, thus forming students who have scientific literacy, social awareness, and critical thinking skills in facing various life problems. The advantage of science learning lies in its ability to

connect scientific concepts with the realities of students' lives (Hanif & Maruti, 2025; Wardani et al., 2024). Learning is no longer oriented towards mastering concepts in isolation, but emphasizes the interrelationships between natural phenomena, human activities, and social values that develop in society. Thus, science not only functions to improve academic competence but also shapes character, environmental awareness, decision-making skills, and the application of moral values in social life (Noviarini et al., 2025; Rahmayati & Prastowo, 2023; Mariana et al., 2025).

Therefore, teachers are required to design learning that is contextual, meaningful, and close to students' real experiences so that the objectives of science learning can be optimally achieved (Purnadewi & Widana, 2023; Marzulina et al., 2025). However, despite these curriculum expectations, many elementary science classrooms continue to rely on decontextualized learning resources that are disconnected from students' local cultural experiences. As a result, opportunities to integrate indigenous knowledge into science learning remain underutilized, reducing the potential for students to develop meaningful conceptual understanding while simultaneously appreciating their cultural heritage. This situation highlights the urgent need to identify and develop contextual learning resources rooted in local culture that can support the implementation of the Independent Curriculum. Therefore, teachers are required to design learning experiences that are contextual, meaningful, culturally responsive, and closely related to students' real-life experiences so that the objectives of IPAS learning can be achieved more effectively.

In line with the development of 21st-century education, science learning has experienced a paradigm shift from learning that is centered on knowledge transfer to learning that is contextual, authentic, and responsive to cultural diversity. This shift emphasizes the importance of integrating indigenous knowledge *into* science learning as a bridge between modern scientific concepts and students' cultural experiences. Indigenous knowledge is the accumulation of experiences, values, beliefs, and practices of a community that develops through long-term interactions with the natural and social environment (Hadlos et al., 2022; Smith et al., 2019). This knowledge not only serves as a community's cultural identity but also contains various scientific concepts that have been passed down through generations (Malapane et al., 2024; Nawawi, 2025). Various studies have shown that integrating indigenous knowledge into science learning can create more meaningful learning experiences Dwiyanti (2026); Kasi et al. (2024), strengthen scientific literacy Delimanugari et al. (2026); Nasution & Nasution (2026), and help students construct scientific concepts based on their experiences. Thus, local knowledge is not seen as something that conflicts with modern science, but rather as a knowledge system that complements modern science in building scientific understanding (Widana et al., 2023; Uswatun et al., 2026).

One approach widely used to integrate local knowledge into science learning is ethnoscience. The ethnoscience approach views various cultural practices of communities as learning resources containing scientific concepts that can be explained through a modern scientific perspective (Imranah et al., 2026; Munira et al., 2024; Sudirman et al., 2025). Through this approach, students not only understand scientific concepts but are also able to appreciate the cultural values that underlie them (Nasution & Nasution, 2026; Zulfa et al., 2026). Various studies report that ethnoscience-based learning contributes to increasing scientific literacy (Hidayah et al., 2024); Nasution & Nasution, 2026), critical thinking skills Munira et al. (2024), environmental awareness, and strengthening students' cultural identity. However, most ethnoscience research still focuses on traditions, local technology, agriculture, traditional food, and the use of natural resources, while traditional games have received relatively little exploration as a source of science learning. Traditional games are a form of intangible cultural heritage that contains various educational, social, ecological, and cultural values (Dewi, 2025; Utama et al., 2025).

In addition to functioning as a means of entertainment, traditional games also represent how people understand the environment, utilize natural resources, build cooperation, and solve various problems in everyday life (Abante, 2024). Various activities in traditional games implicitly contain scientific concepts Lumbantobing et al. (2024); Supiyati et al. (2024), such as force and motion, balance, energy, body coordination, environmental observation, and the use of natural materials. Therefore, traditional games have great potential to be used as a source of ethnoscience-based learning as well as a medium for preserving local culture amidst the decreasing practice of traditional games due to the development of digital technology (Amsikan et al., 2023).

One of the traditional games that is still preserved by the community is Tutulena, a traditional game typical of the Marind tribe that uses bows and arrows made from bamboo and sago palm fronds. In addition to being a means of entertainment, this game is a medium for cultural inheritance that reflects the local knowledge of the community in using natural resources and interacting with their environment. From an ethnoscience perspective, Tutulena contains various concepts relevant to science learning, such as the introduction of plants, material properties, measurement, force, and motion. This game also instills the values of cooperation, sportsmanship, discipline, and responsibility, so it has the potential to be a contextual learning resource based on local culture. However, until now, Tutulena is still more viewed as a cultural activity rather than as a learning resource containing ethnoscience dimensions.

Although ethnoscience studies continue to develop, research examining traditional games, especially Tutulena, as a source for learning science is still very limited. Most research focuses more on media development or testing learning effectiveness, while exploration of the scientific concepts and cultural values contained in traditional games has not been widely investigated. Therefore, this study aims to explore local knowledge and ethnoscience dimensions in the traditional game of Tutulena and analyze its relevance as a learning resource in science learning in elementary schools. The research results are expected to enrich ethnoscience studies and become the basis for developing contextual science learning, based on local culture, and supporting the preservation of cultural heritage. To the best of our knowledge, no previous study has specifically examined the traditional game of Tutulena from an ethnoscience perspective. Previous studies involving Tutulena have mainly focused on its role in cultural preservation, character education, or learning media, without regularly identifying the indigenous scientific knowledge embedded in the game or explaining its relevance to elementary Natural and Social Sciences (IPAS) learning outcomes. This gap constitutes the principal novelty of the present study. Accordingly, this research explores the indigenous knowledge and ethnoscience dimensions embedded in the traditional game of Tutulena and analyzes their relevance to elementary science learning. By explicitly linking local knowledge with scientific concepts and curriculum learning outcomes, this study contributes to the advancement of ethnoscience research while providing a conceptual foundation for developing culturally responsive, contextual, and sustainable science learning that supports the preservation of indigenous cultural heritage.

Method

This study aims

To explore the local knowledge and ethnoscience dimensions embedded in the traditional game of Tutulena and to analyze their relevance to the learning outcomes of Natural and Social Sciences (IPAS) at the elementary school level. To achieve this objective, the study employs a qualitative approach with an ethnographic design, as this method enables a deep understanding of the local knowledge, cultural practices, and meanings constructed by the Marind community regarding the Tutulena game. Through this approach, various scientific concepts inherent in the game's practice

are identified from the community's perspective and subsequently analyzed for their relevance to IPAS concepts taught in elementary schools.

Research Method and Research Design

This study employs a qualitative approach with an ethnographic research design to explore in depth the indigenous knowledge transmitted through the traditional Tutulena game and to identify the ethnoscience dimensions embedded within it as a learning resource for Natural and Social Sciences (IPAS) in elementary schools. A qualitative approach was chosen because the study aims to understand the meanings, values, knowledge systems, and cultural practices that naturally develop within the community, rather than to test hypotheses or measure relationships among variables. Meanwhile, an ethnographic design was chosen because it enables the researcher to describe and interpret the community's cultural practices through direct interaction with participants in their everyday social and cultural contexts. Through this approach, the Tutulena game is understood not merely as a traditional recreational activity but also as a medium for transmitting indigenous knowledge that reflects the community's relationship with the environment, the utilization of natural resources, cultural values, and scientific concepts embedded in everyday life. Throughout the research process, the researcher serves as the primary research instrument, supported by observation guidelines, interview protocols, documentation sheets, field notes, a camera, and an audio recorder.

Participants, Research Subjects, and Sampling Technique

Participants in this study were selected using purposive sampling, a sampling technique in which participants were deliberately chosen based on the consideration that they possess relevant knowledge, experience, and direct involvement with the traditional Tutulena game. This technique was employed to ensure that the data collected were closely aligned with the research objectives and provided comprehensive insights into the indigenous knowledge and cultural values embedded in the game. The study involved 18 participants: two traditional leaders, three cultural experts, three elementary school teachers, five community members who continued to play or preserve the Tutulena game, and five elementary school students who actively participated in the game. Traditional leaders and cultural experts were selected because of their extensive knowledge of the history, philosophy, procedures, and cultural values associated with Tutulena. Elementary school teachers were included to provide perspectives on the relevance of the game as a learning resource for Natural and Social Sciences (IPAS), while community members and students contributed information regarding the actual practice of the game, the transmission of cultural knowledge, and their personal experiences in playing Tutulena. Data collection continued until data saturation was achieved, that is, the point at which information obtained from all participants became repetitive, demonstrated consistent patterns, and no longer yielded new insights relevant to the research objectives.

Research Location, Duration, and Validation of Research Results

This study was conducted in Merauke, South Papua, Indonesia, particularly within communities that continue to preserve the traditional Tutulena game as part of their local cultural heritage. The research was carried out in three phases: preparation, implementation, and evaluation. During the preparation phase, the researcher conducted a comprehensive literature review on Natural and Social Sciences (IPAS) education, indigenous knowledge, ethnoscience, and traditional games to establish the study's conceptual framework. Subsequently, the research site was selected, research permits were obtained, participants were identified, and the research instruments were developed. The implementation phase involved participant observation, semi-structured interviews, documentation, and field note recording. Participant observation was conducted to examine the gameplay process, the use of traditional game equipment, interactions among players, and various activities that reflected ethnoscientific concepts. Semi-structured interviews were conducted with

all participants to explore the history of the game, its philosophical foundations, indigenous knowledge, cultural values, the utilization of natural resources, and the relevance of the Tutulena game as a learning resource for Natural and Social Sciences (IPAS). Supporting documentation, including photographs, video recordings, cultural archives, and other relevant documents, was collected to complement and validate the findings obtained through observations and interviews. During the evaluation phase, all collected data were systematically analyzed and verified to draw conclusions that addressed the research objectives. The trustworthiness of the research findings was ensured through source triangulation, methodological triangulation, time triangulation, and member checking. These validation strategies enhance the credibility, consistency, and accuracy of the findings, ensuring that they faithfully represent the actual conditions and cultural practices observed in the field.

Research Procedures

The research procedure consisted of three major stages: preparation, implementation, and evaluation. The preparation stage involved reviewing relevant literature on indigenous knowledge, ethnoscience, science education, traditional games, and qualitative ethnographic research. Subsequently, research permits were obtained from local authorities and educational institutions. Participants meeting the inclusion criteria were identified, and research instruments, including observation guides, interview protocols, documentation checklists, and field note templates, were developed and validated through expert consultation. During the implementation stage, data collection was conducted using participatory observation, semi-structured interviews, documentation, and field notes. Participatory observation enabled the researcher to observe the complete sequence of the Tutulena game, including the preparation of equipment, game rules, interactions among players, use of natural materials, and expressions of indigenous knowledge directly. Semi-structured interviews allowed participants to explain the cultural meanings, historical development, traditional values, environmental knowledge, and scientific concepts associated with the game. Supporting documentation, including photographs, videos, cultural archives, and relevant documents, complemented observational and interview data. The evaluation stage consists of organizing, coding, interpreting, and verifying all collected data. Findings from multiple sources were compared through triangulation and validated through member checking before final conclusions were drawn.

Data Collection Techniques and Research Instruments

Data were collected using three primary techniques: participant observation, semi-structured in-depth interviews, and documentation. These complementary methods were employed to obtain comprehensive data on the indigenous knowledge, cultural values, gameplay practices, and ethno-scientific dimensions embedded in the traditional Tutulena game. In this study, the researcher served as the primary research instrument, supported by observation guidelines, interview protocols, documentation sheets, a digital camera, an audio recorder, and field notes. Participant observation was conducted to identify the stages of the game, the use of traditional game equipment, players' activities, social interactions, the utilization of natural resources, and the scientific concepts that emerge throughout the gameplay. Semi-structured in-depth interviews were carried out to explore the history of the game, its philosophical foundations, indigenous knowledge, cultural values, the process of cultural transmission, and the relevance of the Tutulena game as a learning resource for Natural and Social Sciences (IPAS). Documentation was used to complement the primary data by collecting photographs, video recordings, cultural archives, traditional game equipment, and other relevant documents related to the Tutulena game.

Prior to data collection, all research instruments, including the observation guidelines, interview protocols, and documentation sheets, underwent content validity assessment through expert judgment involving three experts: a qualitative research expert, an ethnoscience expert, and an

elementary education expert. The results indicated that the instruments demonstrated satisfactory content validity, with Aiken's V coefficients of 0.78 for the observation guidelines and 0.85 for the interview protocols. These results indicate that the instruments possessed acceptable content validity and were appropriate for use in the study. Instrument reliability was evaluated using the Percentage Agreement method among the expert validators, yielding an agreement value of 92.4%, which indicates a very high level of inter-rater agreement. Furthermore, the trustworthiness and dependability of the study were strengthened through the consistent application of observation and interview protocols, prolonged engagement in the field, systematic data recording, and the implementation of source triangulation, methodological triangulation, time triangulation, and member checking. These strategies ensured the consistency, credibility, and dependability of the data collected throughout the research process.

Table 1. Data Collection Techniques and Research Instruments

Data collection technique	Research Instruments	Data Collected
Participatory observation	Observation guidelines, observation sheets, and *field notes*	Game stages, game tools, player activities, social interactions, utilization of natural resources, ethnoscience concepts, and cultural values.
In-depth interview	Semi-structured interview guide, voice recorder, and notebook	History of games, philosophy, local knowledge, cultural values, cultural inheritance processes, ethnoscience concepts, and the relevance of games to science learning.
Documentation	Cameras, mobile phones, photos, videos, and supporting documents	Documentation of game activities, game tools, game environment, cultural archives, and documents that support the results of observations and interviews.

Data Analysis

Data analysis was conducted continuously throughout the research process, beginning with data collection and continuing until the completion of the study. The analysis combined the interactive model of Miles, Huberman, and Saldaña with Spradley's ethnographic analysis to achieve a comprehensive interpretation of the data. The analytical process begins with data condensation, involving the selection, simplification, coding, and categorization of data obtained from participant observations, semi-structured interviews, documentation, and field notes. This was followed by domain analysis to identify the major cultural categories represented in the Tutulena game. Subsequently, taxonomic analysis was performed to examine the relationships among the identified cultural elements. Componential analysis was then conducted to identify ethnoscientific concepts embedded in the game, including force, motion, energy, elasticity, motor coordination, measurement, and the utilization of natural resources. Finally, cultural theme analysis was employed to integrate all findings and develop a comprehensive understanding of the relationship between indigenous knowledge embedded in the Tutulena game and Natural and Social Sciences (IPAS) learning in elementary schools.

The trustworthiness of the study was established based on the criteria proposed by Yvonna S. Lincoln and Egon G. Guba, encompassing credibility, transferability, dependability, and

confirmability. Credibility was ensured through prolonged observation, source triangulation, methodological triangulation, time triangulation, member checking, and peer debriefing. Transferability was enhanced by providing rich and detailed descriptions of the research context, participant characteristics, and research procedures, enabling readers to determine the applicability of the findings to other contexts with similar characteristics. Dependability was maintained through systematic documentation of all stages of the research process, thus providing a clear audit trail. Confirmability was established by maintaining comprehensive records of interview transcripts, field notes, research documents, coding results, and analytical procedures, ensuring that the findings were grounded in empirical evidence rather than the researcher's subjective interpretations.

Results and Discussion

Results

The results of the study show that the traditional Tutulena game contains various dimensions of ethnoscience which are reflected in the preparation stages, making game tools, implementing the game, and using natural resources in the surrounding environment. Local knowledge held by the community is passed down from generation to generation through play practices and reflects various scientific concepts relevant to learning Natural and Social Sciences (IPAS). During the preparation stage, the community first sought materials for making bows and arrows: bamboo for the bow and sago palm fronds for the arrows. The material search process was conducted directly in the surrounding environment, taking into account the characteristics of the plants to be used. During this process, participants were introduced to various types of plants, such as bamboo, sago palm, and coconut palm, along with their characteristics, benefits, and habitats. The traditional leader respondent explained: " *We do not harvest bamboo indiscriminately. The bamboo must be sufficiently mature to ensure it is both strong and flexible. For the arrows, we select straight, lightweight sago palm stalks. This knowledge has been passed down by our elders since long ago."* (traditional leader, Interview, 2026).

This activity demonstrates an understanding of the concept of living things, particularly plant diversity and its use as a natural resource. Furthermore, participants observed the relationship between plants and their growing environments, indirectly introducing them to the concept of ecosystems through interactions between living things and their environments. These findings indicate that the Tutulena game preparation phase serves not only as a process of providing game tools but also as a medium for transmitting local knowledge that integrates biological and ecological concepts into contextual learning, as shown in Image 1.

Image 1. Plants Around the Sago Palm

In the crafting stage, people use bamboo as the primary material for bows and sago palm fronds for arrows. The process of making both tools uses simple tools, such as knives and machetes, to

cut, shape, and trim the materials to the desired size. All materials and tools used are solid objects with distinct characteristics depending on their function. Making a bow requires not only bamboo processing skills, but also local knowledge in selecting bamboo that has a good level of flexibility and strength. The bamboo chosen must be old enough, not easily cracked, and able to be shaped into a curve without breaking. As explained by a Tutulena player: " *If the bamboo is too young, it breaks easily, whereas if it is too old, it becomes brittle. We choose flexible bamboo so that the bow can store energy and launch the arrow further.*" (Tutulena player, interview, 2026).

People carefully shape the bow to produce an elastic curve so that it can store energy when the bowstring is pulled and release it when the arrow is released. This knowledge is acquired through experiences passed down through generations and has become part of the local wisdom of the community in using natural resources. From an ethnoscience perspective, the bow-making process introduces students to the concepts of solids, material properties**,** and elasticity**.** Bamboo was chosen for its strength and flexibility, while sago palm fronds were chosen for their lightness and straightness, allowing them to travel smoothly toward their targets. Thus, the process of making game tools not only teaches the skills of making bows and arrows, but also provides a learning experience regarding the relationship between material characteristics and the function of tools in everyday life.

Observation and interview results indicate that the implementation stage of the Tutulena game contains various dimensions of ethnoscience that develop from the community's empirical experience in using the environment. This local knowledge is passed down through playing practices and becomes the basis for players in determining how to use the bow, release the arrow, and adapt the game to environmental conditions. When players pull the bowstring, the community understands that the greater the pull given, the further the arrow will fly towards the target. This local knowledge demonstrates an empirical understanding of the relationship between force and the motion of objects. As explained by a Tutulena player: " *If the bowstring is pulled harder, the arrow will fly further. We learned that from a young age while playing Tutulen*." (Player, Interview, 2026).

From a scientific perspective, this activity illustrates the change in muscle energy into elastic potential energy in the bow, which then changes into kinetic energy when the arrow is released. This concept is relevant to the material Force and Change and Energy and Its Changes in the science learning of grade III, especially learning outcomes that emphasize students' ability to distinguish types of forces and their effects on the direction, motion, and shape of objects, as well as explaining energy sources, forms of energy, and changes in energy forms in everyday life. A student explained: " *If the wind blows sideways, we have to adjust our aim so that the arrow still hits the target*." (Student, Interview, 2026).

Next, before releasing the arrow, the player first observes the target position, estimates the distance, and pays attention to the wind direction. Based on experiences passed down from generation to generation, people know that wind direction and target distance affect the accuracy of the shot. This activity demonstrates the ability to make observations, simple measurements, and make decisions based on environmental conditions. In science lessons, this activity can be used to develop students' understanding of the influence of force on the direction and motion of objects, as well as their ability to observe natural phenomena through simple investigations. The implementation of the Tutulena game also demonstrates the close relationship between the community and its environment. All game materials are obtained from bamboo and sago trees that grow in the surrounding environment while still paying attention to the sustainability of natural resources. The community only uses bamboo and sago that are old enough so as not to disrupt plant growth or environmental balance. This local knowledge reflects conservation values passed down through generations and demonstrates the harmonious relationship between humans and

nature. This concept is relevant to the Living Things and the Environment material in Grade III and Ecosystems in Grade V, which emphasizes understanding the relationship between living things and the environment, and the importance of preserving natural resources.

Based on these findings, implementing the Tutulena game not only develops playing skills but also serves as a medium for transmitting local knowledge that integrates the concepts of force, motion, energy, environmental observation, and natural resource conservation. These findings indicate that the Tutulena game has a strong ethnoscience dimension and is relevant for integration into science learning as a contextual and culturally based learning resource. Based on the results of the analysis, the ethnoscience dimensions found in the Tutulena game can be mapped into the material and learning outcomes of science as presented in Table 2.

Table 2. Mapping of the Ethnoscience Dimension of the Tutulena Game on Science Learning

Findings on the Tutulena Game	Dimensions of Ethnoscience	Material Science	Learning Outcomes
Utilization of bamboo and sago palm fronds as game tools	Utilization of plants, local knowledge, natural resources	Living Things and the Environment (Class III)	Analyzing the relationship between living things and their environment and efforts to preserve them.
Draw the bow before releasing the arrow	Elastic force and potential energy	Force and Change (Class III)	Distinguish between types of force and their influence on the direction, motion and shape of objects.
Release of arrows towards the target	Change of potential energy into kinetic energy	Energy and Its Changes (Grade III)	Explains energy sources, forms of energy, and the process of changing energy forms in everyday life.
Determine the direction and distance of the target	Motion of objects, observation and simple measurement	Force and Change (Class III)	Find the effect of force on the direction and motion of objects.
Wise use of natural materials	The relationship between humans and the environment	Ecosystem (Grade V)	Analyzing the relationship between ecosystem components and the sustainable use of natural resources.

Research findings indicate that the Tutulena game contains ethnoscientific dimensions, encompassing concepts of natural resource utilization, force, movement, energy, and the relationship between humans and the environment. These concepts developed from the community's empirical experience in using nature and were passed down through traditional games. Thus, the Tutulena game has the potential to be used as a contextual learning resource that integrates local knowledge with science concepts in elementary schools.

Discussion

Research findings indicate that traditional Tutulena games serve not only as cultural and recreational activities but also as a medium for transmitting *indigenous knowledge* that develops through community interactions with their natural environment. Local knowledge reflected in the process of sourcing materials, making tools, and playing games demonstrates that the community possesses an empirical knowledge system regarding plant characteristics, the use of natural resources, and the relationship between humans and the environment. This knowledge is passed down through generations through play practices, thus becoming part of the community's cultural identity. From an *indigenous knowledge perspective*, local knowledge is formed from the community's collective experience in understanding and using the environment to meet their needs (Burgos-

Ayala et al., 2020; Dawson et al., 2021). Therefore, Tutulena games serve not only as a means of entertainment but also as a medium for transmitting ecological knowledge, skills, cultural values, and ways of thinking about nature. These findings reinforce the view that local knowledge is a contextual learning resource because it arises from the community's real experiences and has the potential to be integrated into science education (Ramli et al., 2025; Hasibuan et al., 2024).

This research also shows that each stage of the Tutulena game contains an ethnoscientific dimension that can be explained through modern scientific concepts. In the preparation stage, the community recognized various types of plants based on their characteristics, functions, and habitats before choosing bamboo and sago as the main materials for the game. During the tool-making stage, the community applied empirical knowledge in selecting bamboo with the appropriate flexibility and strength to form an elastic bow. Meanwhile, during the game implementation stage, concepts of force, motion, energy, observation, and measurement develop through the activities of drawing the bow, determining the target direction, and observing environmental conditions. These findings indicate that scientific concepts do not emerge as abstract knowledge, but develop from the community's cultural experiences in interacting with their environment (Devece, 2026; Hogan & Flaherty, 2025; Citrawan et al., 2024). Thus, ethnoscience functions as a bridge connecting local knowledge with modern science through the process of interpreting community cultural practices (Juddin et al., 2026; Maharani et al., 2026). The results of this study expand ethnoscience studies that have previously focused more on traditions, local technologies, agricultural systems, or natural resource utilization, by showing that traditional games are also a rich and relevant source of scientific knowledge for science education.

From a learning perspective, the Tutulena game has characteristics that support contextual learning because students gain direct learning experiences through activities such as observing, trying, predicting, and drawing conclusions based on the phenomena they encounter during the game. This experience aligns with the principles of experiential learning *and* scientific *inquiry,* which position students as active subjects in building knowledge through interaction with the environment. As students search for play materials, they learn about plant diversity and the relationship between living things and their environment. When making a bow, they understand the relationship between the properties of materials and the function of the tool. While playing with the bow, they observe the effect of force on the motion of objects and the changes in energy forms. In this way, science concepts are learned through real-life experiences that are close to the students' lives, making learning more meaningful than simply conveying concepts theoretically in the classroom.

The relationship between the Tutulena game and science learning outcomes shows that traditional games have great potential as a source of culture-based learning. Mapping of ethnoscience dimensions shows that the activities in the game are relevant to the material Living Things and the Environment, Force and Change, Energy and Change, and Ecosystems. Integrating traditional games into learning provides opportunities for students to understand scientific concepts through a cultural context they are familiar with. In addition to improving conceptual understanding, this approach also strengthens awareness of the importance of environmental conservation, sustainable use of natural resources, and appreciation for local cultural heritage. This shows that science learning is not only oriented towards mastering scientific concepts, but also has a role in building the character of students who care about culture and the environment.

A number of studies related to folk games research state that prospective teachers have a very positive perception of using traditional Sasak tribe games in learning ethnoscience. The perception shows that they realize the importance of utilizing traditional games as a medium for integrating local knowledge with science learning (Supiyati et al., 2024). Research states that traditional games

in South Sulawesi not only function as cultural inheritance and guidelines for life in society, but can also be utilized as a medium for teaching scientific concepts, such as biology and materials science (Jamaluddin et al., 2026). Research that states that game top contain various principle scientific, such as torque, moment inertia, center mass, energy rotation, as well as characteristic mechanic material that is in line with natural science material (Martiana et al., 2025). Research that states ethnoscience studies has applied in learning science class IV school basis by integrating draft sound through tool music traditional as well as draft force and motion through traditional dance (S et al., 2025).

Unlike the research mentioned, this research provides new contributions by exploring the traditional Tutulena game approach using ethnography, which can comprehensively reveal local public knowledge of the Marind through game practice. This research not only identifies concepts of science, such as diversity of plants, natural materials, elasticity, force, motion, change energy, ecosystems, and environmental conservation, but also explains how concepts appear from practice, culture, society, and then maps them systematically into the material as well as Elementary School Science Learning (CP). In addition, based on the literature review conducted, no research has been found yet on a special study of the traditional Tutulena game from an ethnoscience perspective. Thus, this research provides a conceptual contribution to the development of ethnoscience-based traditional game studies while also providing a scientific basis for contextual, student-oriented science learning culture and supporting the preservation of public customs knowledge.

The findings of this study have important theoretical and practical implications for the field of science education. Theoretically, this study enriches the body of ethnoscience literature by demonstrating that traditional games are not merely cultural artifacts but also represent indigenous knowledge systems that embody scientific concepts relevant to elementary science education. By regularly identifying the ethnoscience dimensions of the Tutulena traditional game and mapping them to the learning outcomes of the Natural and Social Sciences (IPAS) curriculum, this study extends previous ethnoscience research, which has predominantly focused on traditional technologies, agriculture, food, and environmental practices. Practically, the findings provide teachers with an empirical basis for integrating the Tutulena traditional game into classroom learning as a contextual and culturally responsive learning resource. The results may also serve as a reference for curriculum developers in designing culture-based learning materials and for policymakers in promoting the preservation of indigenous knowledge through formal education. More broadly, this study supports the implementation of the Independent Curriculum by demonstrating how local cultural heritage can be transformed into meaningful learning experiences that simultaneously strengthen students' conceptual understanding, scientific literacy, environmental awareness, and appreciation of indigenous culture.

The main contribution of this research lies in its success in regularly mapping the relationship between the stages of the Tutulena game, local knowledge, ethnoscience dimensions, and the achievements of science learning. In contrast to previous research, which generally utilized traditions, local technology, or agricultural practices as sources of ethnoscience, this research shows that traditional games also contain scientific concepts that can be integrated into the elementary school curriculum. Thus, the Tutulena game not only functions as a cultural heritage of the Marind people, but also becomes an ethnoscience-based learning medium that bridges *indigenous knowledge* with modern science. This finding provides a conceptual contribution to the development of culture-based science learning while expanding ethnoscience studies through the use of traditional games as a learning resource that is contextual, authentic, and oriented towards preserving local culture.

Conclusion

This study shows that the traditional game of Tutulena contains ethnoscience dimensions reflected in the stages of preparation, tool making, game implementation, and utilization of natural resources. Local knowledge (indigenous knowledge) inherited through the game contains scientific concepts related to living things and the environment, the properties of materials, force, motion, energy, and ecosystems. These findings indicate that the game of Tutulena has the potential as a culture-based learning resource that can be integrated into Natural and Social Sciences (IPAS) learning to create more contextual and meaningful learning. The contribution of this study lies in mapping the relationship between the stages of the game of Tutulena, local knowledge, ethnoscience dimensions, and the learning outcomes of IPAS. Further research is recommended to develop traditional game-based learning tools and test their effectiveness in improving students' scientific literacy and thinking skills.

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