

Integration Of Ethnoscience In Physics Learning To Improve Conceptual Understanding Of Maros Muslim University Students

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This study aims to address the shortcomings of several previous studies by providing new contributions through the elevation of more than one example of local culture in the context of ethnoscience integration in physics learning. Involving 53 students, this study assessed their responses to the implementation of ethnoscience integration and its impact on conceptual understanding. The results showed that ethnoscience integration in physics learning at the Muslim University of Maros received positive responses from students, especially related to the relevance of the material to local culture, the suitability of the curriculum, and support for conceptual understanding. These findings indicate that ethnoscience integration significantly improves students' conceptual understanding, as well as connecting scientific knowledge with everyday experiences. Although some students face challenges in applying physics concepts, the majority reported an increase in conceptual analysis skills. Therefore, it is important for educational institutions to continue implementing the ethnoscience approach in the physics curriculum, in order to create relevant learning experiences and support better academic achievement.

Keywords: Ethnoscience integration, physics learning, conceptual understanding.

Introduction

In the era of globalization and digitalization marked by rapid technological advances, modern education increasingly relies on digital devices and innovative learning methods to enhance students' conceptual understanding. However, it is important not to forget the cultural context that underlies the educational process. Culture, as the foundation of a society's identity, plays an important role in shaping how people learn and understand the world [1] [2]. Amidst the increasing development of technology, the student learning process is more directed towards modern learning that utilizes digital devices [3] such as computers, tablets, and internet-based learning applications [4]. Examples of this modern learning include the use of e-learning platforms, interactive videos, computer-based physics simulations [5], to the use of augmented

reality (AR) [6] and virtual reality (VR) to enrich the learning experience [7]. This technology offers wider access to educational resources, makes it easier to deliver material, and allows interaction between teachers and students without time and place limitations [8] [9].

However, this increasingly dominant modern learning can actually make students increasingly distant from their own culture [10]. This is because excessive focus on technology tends to ignore local wisdom, cultural values, and traditional practices that can actually be integrated into learning [11]. For example, in physics learning, natural phenomena explained through local culture (ethnoscience) are often forgotten because students are presented with more universal information without local context [12].

Previous research has shown that many students have difficulty understanding complex and abstract physics concepts, which often makes them feel frustrated [13] [14]. Various factors can influence this problem, including differences in teaching methods applied by teachers. Methods that do not suit students' learning styles can result in confusion and difficulty in understanding the material [15] [16]. In addition, the lack of connection between theory and practice in physics teaching makes it difficult for students to see the relevance of physics concepts in everyday life [16] [17]. This is of course also exacerbated by the lack of relevant cultural context in physics learning, which can make the subject matter feel foreign and unfamiliar to students. The inability to relate physics learning to their local culture can reduce student interest and exacerbate the learning difficulties they experience.

To overcome this problem, most teachers tend to apply modern learning approaches that utilize technology such as simulations [18] , learning videos, and digital platforms [19] [20] . Although this approach is not wrong and can increase student engagement, there is often one important thing that is forgotten, namely the use of local culture as a reference in learning. So without the use of local culture, students tend to see physics as a science that is separate from their daily lives, which can ultimately reduce conceptual understanding.

Without taking into account the cultural context of students, approaches to physics learning often fail to provide relevant and engaging learning experiences. Therefore, Abonyi suggests the need to include cultural dimensions in science learning design so that students can more easily connect with the subject matter [1]. This ethnoscience-based approach has also been recommended by the Science for All Movement initiated by UNESCO in 1991 [2]. In this context, the integration of ethnoscience in physics learning becomes very important. Ethnoscience is scientific knowledge owned by local communities, which in this case can be considered as part of culture [3].

Several research results show that students will find it easier to understand physics concepts when they are explained using a contextual approach [23] [24]. This approach links the subject matter to real situations and students' everyday experiences, which makes physics concepts feel more relevant and meaningful. By connecting theory to real life, students not only learn about the laws of physics in an abstract context, but also see how these principles are applied in their lives [25]. This can increase student engagement in the learning process and encourage them to actively participate in discussions and experiments [26]. In addition, the contextual approach also helps students develop critical and analytical thinking skills, as they are

encouraged to observe, analyze, and draw conclusions from phenomena occurring around them [27].

By linking physics material with local cultural values, students can see the relationship between science and everyday life, which in turn can improve their conceptual understanding. The implementation of this approach is very important to overcome existing problems, so that students not only understand physics theoretically, but can also appreciate and preserve the local culture around them [28].

Previous research tends to focus on one cultural example, so it is less able to describe the diversity of cultural values and practices that can be integrated into physics teaching. For example, it only focuses on the relationship between the Soya-soya dance and the concept of physics [29], and the Gandrang Bulo dance and the concept of physics [30]. These limitations limit the potential of ethnoscience as a rich and diverse learning resource.

To address the shortcomings of several previous studies, this study provides a new contribution by raising more than one example of local culture in the context of physics learning. By including various examples of relevant local cultures as part of the integration of ethnoscience in physics learning, this study provides a new perspective for students in understanding physics concepts through the lens of the culture they are familiar with. Therefore, the purpose of this study is to assess students' responses to the application of ethnoscience integration in physics learning and its impact on conceptual understanding.

Literature Review

Ethnoscience

Ethnoscience is defined as a branch of science that studies scientific knowledge and practices owned by certain traditional or ethnic communities. This knowledge is usually passed down from generation to generation and covers various aspects of life, such as health, agriculture, astronomy, and the environment. Ethnoscience focuses on the unique ways in which communities understand and interpret the world around them based on local experiences, beliefs, and culture [31].

Ethnoscience is a field of research that explores local culture in the form of language, customs, morals, and technology produced by a particular community or individual. The focus of this concept is indigenous knowledge, which is the focus of study in ethnoscience. This knowledge covers various aspects of daily life that are passed down from generation to generation in indigenous communities. One important aspect of ethnoscience is the ability to test the truth of indigenous knowledge through scientific methods, such as literature reviews, scientific explanations, and the creation of scientific works. Thus, ethnoscience plays a role in bridging the gap between local wisdom and conventional science, recognizing the values contained in traditional knowledge, and ensuring proper recognition and integration in a broader scientific context [32]. Indigenous scientific knowledge that develops in society is passed down from generation to generation orally, without following a particular curriculum structure or system. This knowledge is local and is generally a way of looking at natural phenomena in society.

The definition of ethnoscience that has been explained above is in line with the definition of ethnoscience in several research journals, namely: Ethnoscience is a learning approach related the actual knowledge of the community to scientific knowledge [18]. Ethnoscience is an indigenous knowledge system integrated within the local culture, objects, and natural events which people can practice in their daily live “Ethnoscience refers to a person’s knowledge that develops from particular norms and local beliefs that influence one’s understanding of nature [33].

From several expressions related to the definition of ethnoscience above, it shows that the ethnoscience approach has the intention to link the actual knowledge possessed by a community with scientific knowledge. Ethnoscience emphasizes the integration of indigenous knowledge systems within the framework of local culture, objects, and natural events that can be practiced by the community in their daily lives. Thus, the essence of the ethnoscience approach is not only in improving the understanding of scientific concepts, but also in embracing, preserving, and respecting the diversity of knowledge and culture that are an integral part of the learning process.

Conceptual understanding of Physics

conceptual understanding according to Kilpatrick, Swatford & Findell (2001) is a person's ability to understand concepts, operations and relationships found in a particular field. Individuals who have conceptual understanding are able to construct meaning from messages that emerge during the learning process, both through oral and written communication [34].

In the context of physics, conceptual understanding includes the ability to understand basic concepts in physics. This understanding includes not only understanding the formal definitions of these concepts but also the ability to see the relationships and interrelationships between these concepts in the context of physical phenomena that occur in the real world.

In line with the understanding above, McDermott revealed that defining conceptual understanding as a functional understanding or the logical ability to apply knowledge in contexts or scenarios other than the one it was generated or attained [35].

Referring to the definition shows that conceptual understanding involves the ability to use knowledge in an adaptive and flexible way, expanding understanding beyond the initial context in which the knowledge was obtained or produced. So conceptual understanding of physics involves a person's ability to have a deep understanding of basic concepts. in physics and relate these concepts to real-world contexts [35].

Conceptual understanding of physics focuses more on a deep understanding of physics concepts and the relationships between them. It includes a core understanding of the concepts without involving too much mathematics or calculations. Conceptual understanding of physics often involves the ability to visualize the concepts and use analogies or similes to explain complex ideas in a more understandable way [36].

In addition, conceptual understanding also involves the ability to use relevant analogies and metaphors so that complex concepts can be explained more easily. A person who has understanding.

Based on the descriptions above, it shows that understanding concepts is an important basis in understanding physics. Without a good understanding of concepts, it is difficult to achieve success in understanding and applying physics theories in everyday life.

Methods

This study aims to describe the state of a phenomenon, without testing a particular hypothesis so that this type of research is included in the type of exploratory descriptive research [37]. In this context, researchers will identify relevant local cultures as part of the integration of ethnoscience in physics learning. To achieve this goal, researchers will collect data by distributing small summaries containing information about local cultures related to physics concepts. The focus of this study is on the exploration and description of the relationship between local culture and physics concepts, without involving the development of specific learning products or models.

The population in this study were all students of Maros Muslim University who had taken the Basic Physics course with a total of 62 people. Sampling used the random sampling method, namely random sampling without considering the level in the population, so that the population is considered homogeneous. Based on the existing population, determining the number of samples in this study used the Taro Yamane formula [38].

$$n = \frac{N}{N.d^2+1} \quad (1)$$

Description: n = Number of Samples

N = Population size

d^2 = Precision (set at 5% with a 95% confidence level)

Based on this formula, the number of samples (n) for the population (N) was 62 with a precision level of 5%, namely 53 students.

The instrument used was a summary of ethnoscience integration with physics material. In addition, a questionnaire with a Likert scale was used to collect student responses regarding the feasibility of ethnoscience integration in physics learning and its impact on their conceptual understanding.

The data analysis used is the descriptive statistical method, which presents the results in the form of frequency distribution, percentage for each category. Determination of categories using the equation:

$$\text{Interval score} = \frac{\text{SHighest Score}-\text{Lowest Score}}{\text{number of categories}}.$$

Results and Discussion

Results of ethnoscience integration (Relationship between local culture and physics)

The results of the integration of ethnoscience and the description of the relationship between local culture and physics concepts conveyed to students are presented in Table 1. The results

of this integration aim to provide an important foundation in understanding how these two aspects can enrich each other to improve conceptual understanding in physics.

Table 1. The relationship between local culture and physics material as part of ethnoscience integration

Types of local culture	Applied physics concepts
 Pinisi boat artifact The Pinisi boat is a traditional ship that is a symbol of pride for the Bugis-Makassar people in South Sulawesi. Making this boat requires special skills that are passed down from generation to generation. Not only as a means of transportation, the Pinisi boat also symbolizes the maritime spirit and local cultural identity.	a. Hull. Archimedes' Law: The hull of a ship floating on water is a direct example of Archimedes' law. The buoyant force acting on the ship is equal to the weight of the water displaced by the ship. This allows ships with large weights to float on water. Hydrodynamics: The streamlined shape of the ship's hull is designed to reduce water resistance when moving. b. Screen. Newton's Second Law: The sails that are spread catch the wind. The blowing wind exerts a force on the sails, according to Newton's Second Law (force = mass x acceleration). This force then propels the ship forward. Aerodynamics: The curved shape of the sail is designed to catch the wind effectively. This principle of aerodynamics is also applied to aircraft design.
 Pakarena Dance Pakarena Dance is one of the traditional Bugis-Makassar dances characterized by soft and graceful movements. This dance is often performed in traditional events and important ceremonies as a form of respect for ancestors and cultural heritage.	a. Rotational Motion and Angular Acceleration Pakkarena dance often involves circular movements with the hands and body rotating slowly. The concept of rotational motion occurs when the dancer rotates his body or spins the fan gently. Each rotation of the hand or fan produces angular acceleration which describes how quickly the angle of rotation changes over time. b. Static and Dynamic Balance Pakkarena Dance has elegant and smooth movements, requiring dancers to maintain balance both in still and moving positions. Static balance

The graceful movements in the Pakarena dance are not only aesthetic, but also convey a message about humility, respect, and harmony in the lives of the Bugis-Makassar people.

occurs when the dancer remains in a still position without falling, and the gravitational force acting on the dancer's body must be balanced with the reaction force from the floor. While **dynamic balance** occurs when the dancer moves, keeping his center of mass stable even when changing positions.

- c. **Friction.** Friction between the dancer's feet and the floor plays a role in preventing slipping or loss of control during movement. This friction allows the dancer to control the speed and direction of movement better. In the Pakkarena Dance which uses slow movements, static friction is more dominant to maintain balance.



Gandang Bulo Dance

Gandang Bulo Dance is a traditional dance that is often performed with musical accompaniment from bamboo. This dance is known for its dynamic and cheerful movements. Bamboo is used as a musical instrument in the dance.

- a. Sound waves

The bamboo musical instrument used in Gandrang Bulo produces sound when struck. In physics, sound is a mechanical wave that propagates through a medium (air). When the bamboo is struck, the vibrations that occur in the bamboo create sound waves.

- b. **Amplitude and Intensity of Sound .**

The amplitude of the sound wave determines **the intensity** or strength of the sound produced. The harder the bamboo is struck, the greater the amplitude of the vibrations produced, and the louder the sound heard. This can be explained by the relationship between the energy transferred to the bamboo and the intensity of the sound produced.



Chalk

Kapuring is one of the traditional foods from South Sulawesi, especially from the Bugis and Luwu tribes . This food is made from sago flour which is processed by mixing it with hot water to form a thick, chewy dough.

- a. Mixing Sago with Hot Water
Heat Transfer (Conduction and Convection), Change of State. When boiling water is poured into sago flour, the hot water transfers heat to the sago through conduction (direct contact) and convection (movement of hot water). This causes a change in state from the initially solid sago flour to a gel form due to starch gelatinization, where the starch molecules absorb water and expand.
- b. Sago Stirring
Force, Tension, Viscosity . When sago is stirred with a spoon or stirring tool, there is a change in the viscosity or thickness of the sago dough. This stirring involves forces that affect the flow of sago and water molecules.

Description of Student Responses to Ethnoscience Integration

The results of processing student response data regarding the results of cultural exploration as part of ethnoscience integration on the indicator of local cultural involvement in learning are presented in Figure 1 and conceptual understanding of physics through ethnoscience is described in Figure 2.

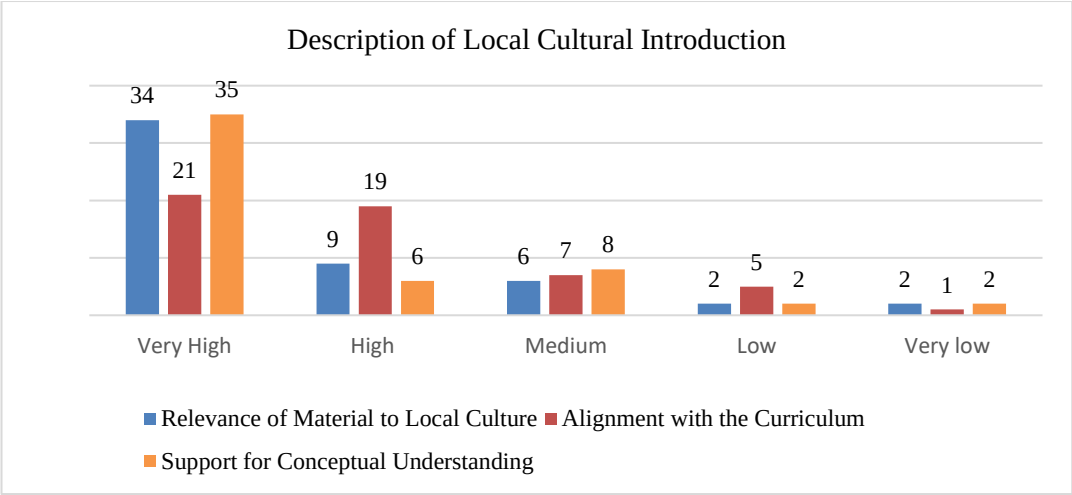


Figure 1Results of data processing Description of Local Cultural Introduction

Based on the indicator data on the involvement of local culture in the physics learning process through the ethnoscience approach in Figure 1, the following results were obtained:

Relevance of material to local culture. The results showed that 34 students (64%) rated the relevance of the material to local culture as very high, followed by 9 students (17%) who gave a high rating. Only 6 students (11%) felt that the relevance was moderate, while 2 students (4%) rated it low, and 2 other students (4%) were very low. This figure reflects that most students feel the importance of integrating local culture into learning materials, which indicates that the materials taught are successfully connected to their local experiences and knowledge. This can increase students' motivation and interest in learning, because they see the connection between academic materials and the culture they experience every day.

Compliance with the Learning Curriculum. Of the 53 students, 21 (40%) felt that the material was very suitable for the learning curriculum, while 19 students (36%) rated it high. A total of 7 students (13%) gave a moderate rating, while 5 students (9%) felt that the suitability was low, and 1 student (2%) rated it very low. These results indicate that the majority of students believe that the material taught is in line with the established curriculum. This is important to ensure that the learning process is not only culturally relevant but also meets the specified academic standards, thus supporting the achievement of expected competencies.

Support for Conceptual Understanding. A total of 35 students (66%) gave a very high rating for the material support for conceptual understanding, while 6 students (11%) gave a high rating. Only 8 students (15%) felt that the support was moderate, followed by 2 students (4%) who gave a low rating, and 2 other students (4%) very low. This shows that the majority of students feel that the material taught is very helpful in understanding complex concepts in physics. Strong support for conceptual understanding is essential, because good understanding will improve students' ability to apply the knowledge they learn in real-life contexts and their local culture.

Overall, data from 53 students showed a strong recognition of the importance of integrating learning materials with local culture, relevance to the curriculum, and support for conceptual understanding. The majority of students gave positive assessments, especially in the relevance of the material to local culture and support for conceptual understanding, indicating that this learning strategy was effective in increasing motivation and understanding. This is in line with previous research results showing that there is an increasing interest in integrating ethnoscience into physics learning [39]. This study identified various trends and patterns in publications related to ethnoscience, and how this approach contributes to students' understanding of physics concepts.

However, there were students who gave low ratings in several aspects, such as the suitability of the material to the curriculum (9% low, 2% very low) and support for conceptual understanding (4% low, 4% very low). This indicates the need for evaluation and improvement in teaching, including the delivery and relevance of the material.

By reflecting and increasing student engagement, it is hoped that all students can feel the benefits of integrating local culture and curriculum in physics learning, creating a more inclusive and effective learning experience.

Conceptual Understanding Through Ethnoscience

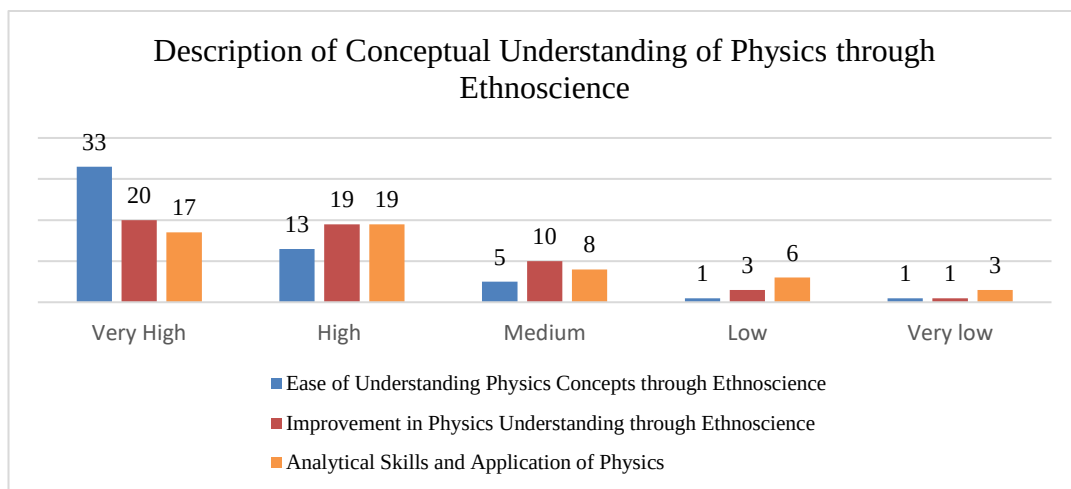


Figure 2 results of data processing Description of Conceptual Understanding of Physics Through Ethnoscience

Based on the graph in Figure 2 which shows a description of conceptual understanding of physics through ethnoscience, the following results were obtained:

Ease of Understanding Physics Concepts through Ethnoscience. Of the total 53 students, 33 students (62.3%) indicated that they found it very easy to understand physics concepts through the ethnoscience approach. This indicates that the integration of local cultural elements in physics learning can improve students' understanding of the material being taught. Meanwhile, 13 students (24.5%) found it easy, and only 5 students (9.4%) found it quite difficult, and 1 student (1.9%) found it very difficult. These figures indicate that the ethnoscience approach is effective in facilitating the understanding of physics concepts, making learning more relevant and contextual for students.

Improving Physics Understanding through Ethnoscience. A total of 20 students (37.7%) reported that they experienced a significant increase in their understanding of physics through ethnoscience, while 19 students (35.8%) felt that the increase was quite good. On the other hand, 10 students (18.9%) felt that their understanding was at a sufficient level, and 3 students (5.7%) felt that they had experienced less improvement, while 1 student (1.9%) felt that there was no improvement at all. These data indicate that most students feel the benefits of physics learning integrated with ethnoscience, which links physics concepts to their daily reality and experiences.

Physics Analysis and Application Ability. The indicators of physics analysis and application ability show that 17 students (32.1%) feel very capable in analyzing and applying physics concepts taught through ethnoscience. Meanwhile, 19 students (35.8%) feel quite capable, but 8 students (15.1%) feel less capable, and 6 students (11.3%) feel a low level of ability, with 3 students (5.7%) feeling very unable. These results indicate that although many students feel they have good abilities in physics analysis and application, there are still a number of students

who need to be encouraged and given more support in improving their abilities, so that they can be more effective in applying physics concepts in real contexts.

Overall, these data support the theory of contextualization of education, which states that the relevance of learning to students' experiences can make the learning process more effective [41]. The ethnoscience approach, which integrates local culture into physics learning, not only helps students understand concepts in depth, but also creates meaningful learning experiences. This is in line with the situational theory by Lave and Wenger, which states that learning is more effective when students are involved in real cultural practices [42], allowing them to learn in a more natural and contextual way.

In terms of understanding physics through ethnoscience, the majority of students felt helped. This shows that ethnoscience serves as an effective tool to facilitate understanding of physics concepts, in line with the theory that contextual and culture-based learning can help students build connections between scientific concepts and everyday life. In addition, this approach also showed positive results in improving the analytical and application skills of physics. Although some students still face challenges in these aspects, overall, ethnoscience makes a significant contribution to students' understanding and skills in physics, indicating the importance of integrating local culture in education to support better academic achievement. Thus, the ethnoscience approach not only improves the understanding of physics concepts but also encourages analytical and application skills among students, although challenges in terms of understanding still need to be overcome.

Conclusion

The results of the study showed that the integration of ethnoscience in physics learning at Maros Muslim University received a positive response from students, especially in three main indicators: the relevance of the material to local culture, suitability to the learning curriculum, and support for conceptual understanding. These findings conclude that the integration of ethnoscience significantly affects students' conceptual understanding. By linking physics concepts to local culture, students can not only understand the material more deeply, but also connect scientific knowledge to their daily experiences.

Although some students faced challenges in applying physics concepts, the majority reported improved analytical and application skills in physics. This suggests that ethnoscience not only serves as a tool to facilitate conceptual understanding, but also contributes to the development of critical skills needed in science education.

Therefore, it is important for educational institutions to continue to develop and implement ethnoscience approaches in physics curricula to create meaningful and relevant learning experiences for students. Thus, the integration of local culture in physics learning not only improves conceptual understanding but also supports better academic achievement and builds a bridge between science and community culture.

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