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Integrating Physics Concepts through Ethnoscience: The Case of *Dodol Garut* Production

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Abstract: This study aims to identify the physics concepts involved in the process of making *Dodol Garut* as a form of local wisdom and to analyze its ingredients from a scientific perspective. The research employs a qualitative approach using direct observation, interviews with a resource person, and literature review. The results indicate that the process of making *Dodol Garut* incorporates various physics concepts, including temperature and heat, viscosity, Newton's laws, phase changes, evaporation, conduction, convection, the second law of thermodynamics, and pressure. Moreover, the main ingredients such as glutinous rice flour, palm sugar, and coconut milk are known to provide health benefits supported by scientific studies. In conclusion, the ethnoscience approach in physics education not only enriches students' understanding of physics concepts but also helps preserve local culture as a meaningful and contextual learning resource.

Keywords: dodol garut; ethnoscience; physics concepts.

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1. Introduction

Indonesia is a country known for its rich cultural diversity and local wisdom spread across various regions. [1] Jufrida argue that local wisdom represents the characteristics of a region that encompass cultural values passed down from generation to generation. Thus, local wisdom can be interpreted as a set of traditions maintained and preserved by a community over time. To strengthen the existence and foster a love for culture and local wisdom, students should apply cultural knowledge in learning activities. This is because regional culture, local wisdom, and the surrounding environment significantly influence students' academic experiences cognitive (thinking), emotional and attitudinal, as well as psychomotor (acting) aspects [2-3].

One example of local wisdom is *Dodol Garut Picnic*. Dodol Garut is a traditional Sundanese confectionery originating from Garut, West Java. It has become a signature souvenir of the Garut Regency and plays an essential role in boosting the region's image and supporting the local economy [4]. Dodol Garut is not only a regional icon but can also serve as a learning medium, especially in the field of science, including physics. This is particularly important because physics is often perceived as an abstract subject that is difficult for students to understand.

The selection of *Dodol Garut* as the object of this research is based on its production process, which still combines traditional and modern techniques, and involves physical phenomena that can be directly observed. One relevant approach to bridge scientific knowledge and local wisdom is the ethnoscience approach. It explores how people's traditions, practices, and worldviews relate to their environment and how they apply that knowledge in daily life. Ethnoscience spans various disciplines, including science,

agriculture, pharmacy, and the study of plants and animals [5]. As such, ethnoscience serves as a foundation that connects culture with scientific knowledge. In education, ethnoscience plays a crucial role, as it involves understanding natural conditions and phenomena [6]. It is also used as a learning strategy to create learning environments and experiences that incorporate cultural elements into classroom activities [7].

The ethnoscience approach offers a solution to problems faced by students, such as the lack of conceptual understanding, by allowing them to directly observe various processes and phenomena found in local wisdom. By directly connecting learning to cultural activities such as the production process of *Dodol Garut*, students can more easily grasp physics concepts in real-life applications. Therefore, it is necessary to conduct an in-depth study to explore the relationship between local cultural processes and physics concepts from a scientific perspective. This research aims to identify the physics concepts embedded in the local wisdom of *Dodol Garut* and to analyze its raw materials from a scientific point of view.

2. Materials and Methods

This study employs a qualitative research method using observation, interviews, and literature review. Qualitative research involves collecting data in the form of sentences, words, ideas, and documentation such as images or videos [8-9]. This method was chosen because it is considered the most appropriate for deeply exploring the relationship between local cultural practices and physics concepts present in the production of *Dodol Garut*. Through a qualitative approach, the researcher can comprehensively understand various contexts social, cultural, and scientific based on direct field experiences.

Observation was conducted by directly observing the *Dodol Garut* production process to identify the stages involved. This observation helped the researcher gather information on physical phenomena occurring during the production [10]. This was complemented by interviews with key informants to obtain more comprehensive information. The data provided were recorded and supported by electronic devices to capture images, videos, and audio recordings.

In addition, the researcher conducted a literature review by examining various articles and relevant sources related to the topic to strengthen the theoretical framework and support the findings from the observations and interviews. All collected data were then further analyzed to extract information regarding scientific knowledge, local community knowledge, and physics-related concepts.

3. Results

Indonesia is a country known for its cultural diversity, which includes language, customs, arts, traditional ceremonies, and traditional cuisine. Indonesian food is highly sought after by international visitors, and the country offers a wide variety of traditional dishes. One example is Garut, a city famous for its sweet treat known as *Dodol Garut Picnic* [11]. Dodol Garut is a traditional confection made from glutinous rice flour, palm sugar, and coconut milk. It is often brought home as a souvenir from Garut, West Java. According to local sources, the dodol is made using high-quality raw materials directly sourced from local farmers, including glutinous rice (processed into flour), palm sugar, and coconuts (used to extract coconut milk). These carefully selected ingredients contribute to the distinctive taste and high quality of Dodol Garut Picnic. As a result, despite being free from preservatives, Dodol Garut can last up to five months at room temperature.

Historically, as recounted by local informants, the origin of dodol dates back to a time when a native woman prepared a sweet dish for her Dutch employer. With only limited ingredients (glutinous rice flour, palm sugar, and coconut milk) she mixed them all together, unsure of what to make, and stirred the mixture thoroughly. When the dish was ready, she served it, and when asked about its name, she spontaneously said "dodol," inspired by a traditional children's game called *doleang*, which involves spinning. The

word *doleang* also means "to stir," which reflects the dodol-making process that requires continuous stirring for around four hours to achieve a soft and chewy texture.

Thus, dodol has become a symbol of Garut Regency, playing a vital role in enhancing the region's identity and supporting the local economy [4]. Based on the analysis, the raw materials used in dodol production can be integrated with scientific knowledge. The table below (Table 1) presents the ingredients used in Dodol Garut production, comparing indigenous knowledge with scientific (physics-related) perspectives.

Table 1. Ingredients Used in Dodol Garut Production Based on Indigenous Knowledge and Scientific Understanding.

Topic	Indigenous Knowledge	Scientific Knowledge
Raw Materials	Using raw materials directly from farmers, such as glutinous rice, palm sugar, and coconut, to achieve optimal results	**White Glutinous Rice (Oryza sativa L. var glutinosa)** **Classification** • Division: Spermatophyta • Class: Monocotyledoneae • Order: Poales • Family: Gramineae/Poaceae • Genus: Oryza • Species: Oryza sativa L. var glutinosa **Coconut (Cocos Nucifera)** **Classification** • Division: Magnoliophyta • Class: Liliopsida • Order: Arecales • Family: Arecaceae • Genus: Cocos • Species:Cocos Nucifera **Sugar Palm (Arenga pinnata Merr.)** **Classification** • Division: Magnoliophyta • Class: Liliopsida • Order: Arecales • Family: Arecaceae • Genus: Arenga • Species:Arenga pinnata Merr.
Palm Sugar	Palm sugar is used in the dodol mixture as a natural sweetener.	The glycemic index contained in palm sugar is very low, only 35. The glycemic index is a measure of how quickly foods containing carbohydrates are converted into glucose (Puspaningtyas et al., 2020). Furthermore, palm sugar is also one of the natural sugars that is beneficial for health [12]
Coconut Milk	The natural fat content in coconut milk makes the texture of dodol softer and chewier.	Coconut milk is a product derived from the coconut fruit. The coconut fruit contains compounds such as tannins, flavonoids, and polyphenols, which are beneficial for health [13].
Glutinous Rice Flour	Glutinous rice flour helps provide a thick and elastic consistency, making the texture of dodol soft and chewy.	Glutinous rice contains several vitamins, including vitamins C, B12, B1, and E, as well as minerals that have been proven to be beneficial for overall health and skin beauty. In addition, due to its high antioxidant

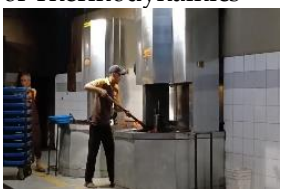
Topic	Indigenous Knowledge	Scientific Knowledge
		content, glutinous rice is also commonly used as a raw ingredient in body scrub products [14].

Ethnoscience is an approach that connects local community knowledge with scientific knowledge, providing a more in-depth and comprehensive understanding. In addition, ethnoscience also plays an important role in preserving local culture. Based on Table 1, there is a strong relationship between traditional knowledge and science, especially in food processing, with numerous health benefits derived from the raw ingredients used in making dodol. Scientific knowledge helps objectively explain the benefits of each ingredient—such as palm sugar, which is known as a natural sweetener and scientifically recognized for its low glycemic index, beneficial to health. Coconut milk, furthermore, contains natural fatty acids that have the potential to promote skin health and help prevent cancer. The use of raw materials sourced directly from farmers reflects local wisdom in sustaining natural resources continuously.

The process of making dodol combines both traditional and modern methods. The traditional process involves the use of a wood-fired stove, which is a traditional tool that utilizes wood—a natural resource that is easily accessible. This method helps preserve the distinctive taste of dodol. On the other hand, the modern process uses machines, such as automatic stirrers, which speed up and simplify the production process. In addition to machines, manual stirring by human labor is also used. Furthermore, based on the analysis, the process of making Dodol Garut can be connected to various physics concepts, which can be seen in Table 2.

Table 2. The Relationship Between the Dodol-Making Process and Concepts in Physics

Topic	Indigenous Knowledge	Concepts in Physics
Temperature and Heat  **Figure 1**	Heating is done to melt the sugar and thicken the dough mixture.	Temperature can cause a change in the physical state of a mixture of materials, such as in the process of melting sugar. Sugar undergoes a change from a solid to a liquid phase. Then, heat transfer from the flame to the pan, known as conduction, occurs—when we heat one end of the pan, the other parts also become hot. This is caused by the transfer of heat from a higher temperature to a lower temperature [15].
	Stirring the dodol is done to evenly distribute the heat so it doesn't burn.	During the constant stirring process of dodol, evaporation occurs [16], as most of the water in the dodol mixture evaporates due to the heat."
Force  **Figure 2**	In addition to using machines, the stirring of dodol is also assisted manually by human labor continuously to ensure that all ingredients are evenly mixed and do not clump together.	**Newton's First Law** "An object will remain at rest or move with constant velocity unless acted upon by an external force" [17]. The stirring process is done to overcome the property of inertia. If not stirred, the mixture will remain at rest and will not mix properly, which can lead to burning. **Newton's Second Law** "The acceleration of an object is directly

Topic	Indigenous Knowledge	Concepts in Physics
		proportional to the force applied to it and inversely proportional to its mass"(Safitri et al.,2023). The movement of the mixture is influenced by the acceleration or velocity of the force applied when stirring the mixture. The larger the mass of the mixture and the thicker its consistency, the greater the force required to stir the dodol mixture, as this is done to ensure even heat distribution.
Phase Change  **Figure 3**	All the mixed ingredients are cooked until done. The cooking process takes about 4 hours until the mixture undergoes a change in texture, from liquid and semi-solid to thicker and firmer over time.	Both naturally and through human intervention, an object can undergo changes in properties, including changes in state, shape, color, texture, and flexibility[18]. Viscosity is a measure of the thickness of a liquid caused by friction between the molecules that make up the liquid [18]. As the cooking process of the mixture of glutinous rice flour, sugar, and coconut milk continues, it becomes thicker and stickier. This happens because the flour undergoes gelatinization, where the starch molecules absorb water, thickening the mixture into a denser texture.
Convection and Second Law of Thermodynamics  **Figure 4**	The dodol is left in a certain room to cool down.	Convection is the process of heat transfer through a medium, followed by the movement of particles[15]. This heat transfer process occurs from the high-temperature dodol to the lower-temperature environment, in accordance with the second law of thermodynamics, which states that 'heat flows from a body with high temperature to a body with low temperature and does not flow in the opposite direction' [19].
Force and Pressure  **Figure 5**	The dodol, which has been left at room temperature overnight to cool down, is then cut. The dodol is sliced into pieces about 2-3 cm, then packaged and ready for sale.	During the cutting process of the dodol, force and pressure are involved. The force is applied through a tool, which is the knife. This force generates pressure on the surface of the dodol. The greater the force applied to an object (F), in this case, the knife, the greater the pressure exerted on the surface (dodol). Furthermore, the smaller the surface area (knife tip), the greater the pressure generated, making it easier to cut the dodol [20].

Based on the observations, several stages in the process of making *dodol* can be linked to physics concepts. It begins with melting palm sugar, which relates to the concept of temperature and heat, followed by mixing other ingredients such as coconut and glutinous rice flour. This process, which takes place over a wood-fired stove, is also associated with heat transfer, specifically conduction. These concepts can be integrated into high school physics learning, especially within the *Merdeka Curriculum*, which emphasizes a contextual and project-based approach. In classroom practice, teachers can begin by presenting documentation of the *dodol* production process, then guide students

to identify the types of heat transfer involved—such as conduction when the pan is in contact with the fire, convection within the stirred mixture, and radiation from the heat source.

Additionally, Newton's First and Second Laws, observed during the stirring process, can serve as an introduction to dynamics and motion. Educators can integrate the force required to stir the mixture with mass and acceleration, and then involve students in simple experiments using learning aids to understand the relationship between force and motion. Furthermore, during the *dodol* cooking process, evaporation, thickening (viscosity), and phase changes in taste and texture occur as water content decreases, making the *dodol* firmer and chewier. Once cooked, the *dodol* is left to cool in a special room overnight, where heat transfer takes place from the hot *dodol* to the cooler surroundings, in accordance with the Second Law of Thermodynamics. The final stage is the cutting process. The cooled *dodol* is sliced into small pieces, usually 2–3 cm in size, using a sharp knife. In this process, the concept of pressure related to static fluids applies. For example, when the *dodol* is pressed, students can explore the relationship between force, surface area, and pressure. Activities like this can be developed into project-based experiments to support experiential learning.

The physics concepts found in the *dodol* production process, which is rooted in local wisdom, can be connected to physics learning to help foster interaction between teachers and students. By applying the ethnoscience approach, students gain a deeper understanding because they directly see, hear, read, and learn about cultural heritage that exists in their daily lives, which can serve as a meaningful source of knowledge. On the other hand, students will come to understand the importance of culture in the learning process, making it easier for them to apply difficult physics concepts. This can help develop students' potential to think logically and understand concepts through reasoning [21], thus creating meaningful learning experiences.

4. Discussion

The study of Dodol Garut's production process through an ethnoscience approach has revealed a strong intersection between traditional knowledge and scientific principles, particularly in physics. By examining the preparation methods and the raw materials involved, this research has highlighted how the local wisdom embedded in Dodol Garut production provides an ideal platform for integrating physics concepts into the classroom. The findings underscore the relevance of ethnoscience as a pedagogical tool that can make scientific learning more accessible and engaging for students [22-23].

The physics concepts identified during the study—such as temperature and heat, viscosity, Newton's laws of motion, phase changes, evaporation, conduction, convection, the second law of thermodynamics, and pressure—are intricately connected with the steps involved in making Dodol Garut. Each of these principles manifests in real-world activities, making them easier for students to grasp. For example, the process of melting sugar and heating the mixture to the right temperature is a direct application of the concept of heat transfer and phase changes, while the manual stirring involved in Dodol production illustrates the practical application of Newton's First and Second Laws of Motion. The second law of thermodynamics is also evident in the cooling process, where the heat from the dodol flows to the surrounding cooler environment, an example of energy dispersion.

Furthermore, the ingredients used in Dodol Garut, such as glutinous rice, palm sugar, and coconut milk, offer not only a deeper understanding of their scientific properties but also highlight the health benefits tied to their use. Palm sugar's low glycemic index and coconut milk's natural fats have been scientifically proven to provide health benefits, which aligns with the indigenous knowledge of these ingredients' positive effects on the body [24-25].

This study also shows the potential for using ethnoscience to bridge the gap between cultural heritage and scientific education. By incorporating local wisdom into the curriculum, students can see the direct application of abstract scientific concepts in their daily lives [26], [27]. This approach can increase their motivation to learn and help them understand the practical implications of science in real-world contexts. It also fosters a greater appreciation for cultural traditions and the importance of preserving them.

Additionally, this research contributes to the growing body of literature on the application of ethnoscience in science education. Previous studies have shown the positive impact of incorporating local knowledge into the curriculum, enhancing students' critical thinking skills and making science more relevant to their lives [28-30]. By expanding the use of ethnoscience in physics education, we can cultivate a more inclusive and holistic approach to learning, one that values both scientific inquiry and cultural heritage.

However, there are challenges in fully integrating ethnoscience into formal educational settings. Teachers may face difficulties in aligning traditional knowledge with standardized curricula and may require further training to effectively incorporate these concepts. Furthermore, there is a need for additional research to explore how various types of local wisdom can be systematically applied to different scientific fields.

5. Conclusions

The findings of this study indicate that the ethnoscience approach can serve as an effective teaching strategy for connecting physics concepts with real-life experiences through local wisdom. The process of making Dodol Garut involves various relevant physics phenomena such as heat transfer, Newton's laws, viscosity, and the second law of thermodynamics which can be used as meaningful learning contexts in the classroom. Therefore, educators are encouraged to integrate such cultural phenomena into physics instruction to create contextual, meaningful, and more easily understood learning experiences for students. Teachers can utilize documentation of the dodol-making process as instructional media, develop simple experimental projects based on its production stages, and encourage students to explore other local cultural practices with educational potential. However, this study has several limitations. It focuses solely on one form of local wisdom Dodol Garut thus not representing the rich diversity of Indonesian culture that could be explored from a scientific perspective. In addition, the qualitative approach used in this research does not provide quantitative data on the impact of the ethnoscience approach on students' learning outcomes. Therefore, future research is recommended to examine the effectiveness of ethnoscience through quantitative or mixed-method approaches, to develop structured ethnoscience-based learning models, and to explore other forms of local wisdom that can be integrated into physics or science education more broadly. This approach is expected to foster learning that is not only scientific but also rooted in students' cultural backgrounds and real-life experiences.

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