

An Exploratory Study of the Ethnophysics Concept in the Spiritual Dance of Mpa'a Toja-Kalero Donggo to Identify Physics Learning Content as a Learning Resource

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Abstract. Ethnophysics discusses the interaction between culture and physics concepts utilized as learning resources. The use of resources close to the environment fosters contextual learning and can help students develop critical thinking skills. This research assesses physics concepts in the traditional dance of Mpa'a Toja-Kalero Donggo. The research goal is to identify physics content that can be used as a learning resource. The research is descriptive-qualitative, using the content analysis method. The object of research is the Mpa'a Toja-Kalero video, documentation of Majelis Kebudayaan Mbojo (Makembo), which was determined through purposive sampling. Methods of data collection include observation and literature review. The observation method is used to examine the various elements of mpa'a Toja-Kalero, such as the music and dance moves. Meanwhile, the literature review focused on analyzing the physics concepts in the spiritual dance Mpa'a Toja-Kalero. According to the findings of the analysis, Mpa'a Toja-Kalero contains physics concepts such as sound waves, regular straight motion, centripetal force, air resistance, center of mass, moment of inertia, and downward vertical motion.

Keywords: Ethnophysics, physics concepts, mpa'a toja-kalero, donggo

Introduction

Good learning is based on the learner's experience or perception. Acceptance of new ideas is based on perception. Therefore, the learning design must consider employing resources close to the students' environment in order to make the process more contextual and meaningful. This is reinforced by Hidayati et al. (2020) and Mudjid et al. (2022) assertions that formal learning implementation must be tailored to student needs, materials, and trends, and the learning process must be contextualized. The learning process in the merdeka curriculum also involves students' contextual experiences. This is in keeping with Mustaghfiroh (2020) remark that the characteristic of the independent curriculum is contextualization in learning.

The merdeka curriculum is based on Ki Hajar Dewantara's educational philosophy, which concludes that each student has their own learning style that must be developed in order for them to achieve cognitive process independence. The achievement of the merdeka curriculum is measured by the ability to realize the pancasila student profile, which includes noble character, independence, critical reasoning, creativity, mutual cooperation, and global diversity (Rusnaini et al., 2021). A cultural exploration study is one of the approaches that can be used to develop the pancasila learner profile. Empowering students' learning experiences will increase their understanding of the concepts studied.

Furthermore, schools cannot ignore cultural elements in science learning because local culture is intertwined with students' daily lives (Fiqry & Agustinasari, 2019; Bahtiar et al., 2020).

What remains a concern now is students' perceptions of physics. Students consider physics a difficult subject to understand because the learning applied tends to prioritize technical mathematical solutions. Physics is also a subject that requires a real understanding of concepts, so learning media can help visualize a concept concretely (Ramadani & Nana, 2020). One aspect of the perspective to be studied as a concrete physics learning material is culture (Walid et al., 2022). As a result, a learning strategy that encourages students to think critically when grasping physics concepts is required. Ethnophysics is a technique that can be used to help students understand physics concepts. Ethnophysics is the study of physics through the lens of local wisdom (Astuti & Bhakti, 2021). The results Sari et al. (2023) research concluded that ethnoscience can be used as a learning resource if combined with culture, special foods, and local wisdom from the environment that supports learning materials and the reconstruction of indigenous science knowledge with scientific knowledge.

Many cultures and traditions are carried out by the people of Bima, including kalondo lopi (lowering fishermen), mbolo weki (deliberation), rimpu tembe (woven fabric veil), sagele (planting accompanied by traditional music), ntumbu (banging heads in memory of ancestors), and Mpa'a Toja-Kalero traditional dance in Mbawa Village, Donggo District, Bima Regency (Muttaqin et al., 2021). However, these cultures and traditions have not been widely utilized as physics learning resources. One of the Bima community cultures that can be used as a learning resource is Mpa'a Toja-Kalero.

Mpa'a Toja-Kalero (Toja-Kalero Dance) is a traditional spiritual dance from the Donggo Tribe in Mbawa village, Donggo District, Bima, West Nusa Tenggara. Mpa'a Toja-Kalero was originally used in the Donggo people's ancient belief rituals (Muttaqin et al., 2021). Along with the development of civilization and the assimilation of cultures and beliefs, Mpa'a Toja-Kalero is often featured in arts and cultural performances. The researcher's initial analysis showed that Mpa'a Toja-Kalero contains several physics concepts, such as sound waves, regular straight motion, circular motion, and the concept of balance. The physics concepts are identified through the components and movement patterns in the dance. So this research aims to examine more deeply the content of physics concepts in the traditional dance Mpa'a Toja-Kalero so that it can be utilized as a learning resource.

Methods

This research is descriptive-qualitative, using the content analysis method (Prior, 2020). The subject of this study is a video recording of Mpa'a Toja-Kalero, which is the documentation of the Mbojo Cultural Assembly (Makembo), as determined by the purposive sampling technique. The Makembo video documentation was chosen with the consideration that the shooting location is in the Donggo area, so it can be ascertained that the dancers are natives of Donggo. In addition, the video has a clear image quality that is needed to analyze each dance movement.

The data collection procedure goes through several steps, namely: 1) categorization. In this step, observation of the video is carried out, which aims to categorize the elements in the dance and the movement patterns in each dance step. 2) Coding. This step describes and analyzes the characteristics of each dance movement more specifically.

The data analysis technique is to interpret the observation results. In this step, a literature review was conducted to investigate the concepts of physics that correspond to

the spiritual dance movements of Mpa'a Toja-Kalero Donggo. Then classify physics concepts based on the basic competencies of the curriculum.

Results and Discussion

The teacher's role is not only to convey knowledge; they must also be able to facilitate the learning process by providing resources that meet the needs of students. Supriadi (2017) defines learning resources as everything that can support the development of cognitive processes, including all sources that teachers can use to encourage the development of knowledge. Learning resources vary greatly in their function, necessitating the teacher's ability to explore them in accordance with students' goals and needs.

Learning resources that are close to the students' environment, such as local wisdom, are good. Local wisdom can be utilized as a source for learning physics through ethnophysics, where the process of presenting materials is associated with culture. The content of local wisdom is said to be integrated with learning if there is an implementation of values, traditions, and culture in it, so ethnophysics requires the ability of teachers to be able to integrate general knowledge with scientific physics (Sudarmin et al., 2017; Usmeldi & Amini, 2020). Based on the study's findings, the ethnophysics approach can make use of regional dances. In essence, every dance movement pattern contains physics concepts and can thus be used as a learning resource. Furthermore, using art as a learning resource can give students a contextual picture of physics material. One of the dances that can be studied as a physics concept payload is Mpa'a Toja-Kalero.

Mpa'a Toja-Kalero is a spiritual dance that originated in Mbawa, Donggo District, Bima Regency, NTB. This dance is a classic or old dance that is believed to have been created in the 7th century. This dance has its own set of movements that have not changed since the beginning of its creation. This dance is performed by the Donggo community to honor the dead as a form of mourning (Muttaqin et al., 2021). The dancers wear all black clothes, namely kababu clothes, and typical Donggo fabrics, namely tembe me'e and tembe 'dala. The study of physics concepts in Mpa'a Toja-Kalero can be seen in Table 1.

Table 1. Analysis of Physics Concepts in Mpa'a Toja-Kalero Donggo Spiritual Dance

Movement Element/Pattern	Dance Movements	Physics Concepts
Music, Kalero's tone poem	This dance begins with the sound of drumming that accompanies the dancers into the dance arena. Then, at the core of the dance, gongs and sarone musical instruments are added. In addition, the dance is also accompanied by Kalero's tone poem. 	The drum is a musical instrument with a membrane made of animal skin on both sides. The membrane is stretched very strongly. When the membrane is beaten or hit, it will cause vibrations, and these vibrations will cause sound waves. Sound waves travel through the air so that they can be heard. Like the drum, the sound of the gong and sarone, as well as Kalero's tone poem, propagates through the air so that it can be heard. The equation for the speed of

propagation of sound in the air can be written:

$$v = \frac{\lambda}{T}, v = \lambda \cdot f$$

Information:

v = Speed of sound (m/s)

λ = Wavelength (m)

T = Period (s)

f = Frequency (Hz)



Part of dance step 1

The dancer enters the dance arena with a small run and regular steps, spreads the shawl (tembe 'dala), and then gives a respectful greeting.

The dancer's movement with regular steps indicates that the speed is constant. This is related to the concept of regular straight motion in physics (GLB). GLB is the constant speed motion of an object on a track. The GLB formula can be written:

$$s = v \cdot t$$

Information:

s = Distance (m)

v = Speed (m/s)

t = Time (s)



Part of dance step 2

The dancer grasps the tembe 'dala, then snaps and rotates towards the dancer's body.

The concept of physics in the circular motion of tembe 'dala is in accordance with the concept of centripetal force, which is the force that makes objects move in a circle. The centripetal force formula can be written:

$$F_s = m \cdot a_s$$

$$F_s = m \cdot \frac{v^2}{r}$$

Information:

F_s = centripetal force (N)

m_s = Object mass (kg)

a_s = centripetal acceleration (m/s²)

v = linear velocity (m/s)

r = Radius of a Circular (m)



Part of dance step 3	The movement of Mpa'a Toja-Kalero is dominated by the movement of waving the tembe'dala back and forth and then flapping the tembe'dala like a bird's wing.	The physics concept that corresponds to this movement is air drag. The direction of the force is opposite the direction of the cloth, while the size of the force depends on the surface area of the cloth being hit. The larger the surface area, the greater the drag force.
Part of dance step 4	Jinjit is a typical foot movement in Mpa'a Toja-Kalero. Jinjit is where the heel is raised and the weight of the body rests on one point.	The concept of physics in this movement is related to the center of mass. The center of mass is the balance point of an object. The center of mass formula can be written: $x = \frac{x_i m_i}{\sum m_i}$ Information: m = Object mass (kg) x = particle position
Part of dance step 5	The dancer makes a circular motion, then makes a small circle with the position of the hand in the center becoming the center, then moves around.	The dance movement in this pattern fits the concept of the moment of inertia, which is a measure of the inertia of an object to rotate on its axis. The moment of inertia equation can be written: $I = m \cdot R^2$ Information: m = Object mass (kg) R = radius of rotation (m)
Part of dance step 6	Dancers perform a standing movement, then slowly descend so that they sit, using their knees and the bottom of their toes as	This movement from a standing position then slowly descending in the concept of physics corresponds to downward vertical motion. The formula for

support while swinging tembe
'dala left and right alternately.

downward vertical motion can be
written:



$$v_t = v_0 + g \cdot t$$

$$v_t^2 = v_0^2 + 2 \cdot g \cdot h$$

$$h = v_0 \cdot t + \frac{1}{2} \cdot g \cdot t^2$$

Information:

v_0 = initial velocity (m/s)

v_t = speed after t seconds (m/s)

t = traveling time (s)

h = height (m)

g = acceleration due to gravity (m/s^2)

Based on the analysis of physics concepts in table 1, there are several elements in Mpa'a Toja-Kalero, namely music, singing, and movement. These three elements can be a source for learning physics concepts including: sound, regular straight motion (GLB), centripetal force, air resistance, center of mass, moment of inertia, and downward vertical motion. The results of the ethnophysics study, as listed in Table 2, can be used as learning resources at the SD/MI, SMP/MTs, and SMA/MA levels, according to the regulation of the minister of education and culture of the republic of indonesia No. 37 of 2018 concerning amendments to the regulation of the minister of education and culture No. 24 of 2016 concerning core competencies and basic competencies for lessons in the 2013 curriculum in primary and secondary education.

Table 2. Classification of Ethnophysics Study Materials Based on Basic Competencies

No.	Topic	Class	Level of Education	Basic Competency
1.	Sound	IV	SD/MI	3.6 Apply the properties of sound and its relationship to the sense of hearing.
		VIII	SMP/MTs	3.11 Analyze the concepts of vibration, waves, and sound in everyday life, including the human hearing system and the sonar system in animals.
		XI	SMA/MA	3.10 Apply the concepts and principles of sound and light waves in technology.
2.	GLB, Downward Vertical Motion	VIII	SMP/MTs	3.2 Analyze straight motion, the effect of force on motion based on Newton's Laws, and its application to the motion of objects and the motion of living things.
		X	SMA/MA	3.4 Analyze the physical quantities in straight motion with constant speed and straight motion with constant acceleration and their applications in everyday life, such as traffic safety.

	Moment of inertia, Center of mass	XI	SMA/MA	3.1 Apply the concepts of torque, moment of inertia, weight point, and angular momentum in rigid bodies (static and dynamic) in everyday life, for example, in sports.
4.	Air drag	IV	SMP/MTs	3.4 Relate force to motion in events in the surrounding environment.
5	Centripetal force	X	SMA/MA	3.6 Analyze the physical quantities in circular motion with a constant rate and their application in everyday life.

As a learning resource, through Mpa'a Toja-Kalero, physics material can be presented contextually. This statement is in line with what is expressed (Agustinasari & Susilawati, 2018; Husna & Kuswanto, 2018) which states that local potential makes physics concepts more contextual. The contextual presentation of material is very important to help students integrate material with learning resources so that it can improve critical thinking skills. In addition to improving critical thinking skills, the use of learning resources that are close to everyday life, both in terms of material exposure and problems or questions, will help improve students' representative skills (Rosengrant et al., 2009). The argument is supported by the results of research by Risdianto et al. (2020), which show that the application of ethnoscience-based direct instruction learning models affects critical thinking skills because, in the process, students connect the material learned in class with what they experience in everyday life. Therefore, it motivates students to actively participate in the learning process. The connection between ethnoscience and the theories used is very helpful in ongoing learning activities in accordance with the knowledge and experience of the students themselves (Astuti et al., 2022).

Utilizing dance as a learning resource provides an interesting experience for students. The existence of media that supports physics learning can increase student interest (Astuti et al., 2020). Learning interest is very important for students because it is related to how much they accept the material being studied. Interest is also closely related to student involvement in learning activities. Students who are actively involved in learning have the opportunity to better understand and develop knowledge of physics concepts. In addition, according to the results of Anthony's research (2017), student involvement in learning activities, especially those based on ethnophysics, contributes to reducing the gap between the school curriculum and the social and cultural environment.

Cultural integration in the classroom can be a place to introduce various cultures to students. This is in line with the research of Munandar et al., (2022), who analyzed the potential of ethnoscience-based learning and found an increase in students' love for the local wisdom of Bima. Through local wisdom-based learning, students get to know local culture so that there is a desire to maintain, preserve, and introduce it among young people, as well as increase their awareness and participation in environmental issues (McCarter & Gavin, 2011; Usmeldi & Amini, 2020). The values embodied in local wisdom can shape student character. As a result, it can be concluded that, in addition to assisting students in understanding physics concepts contextually, the use of local cultural learning resources can also provide knowledge and increase students' love for their local wisdom.

Conclusion

Based on the research results, it can be concluded that the traditional mpa'a Toja-Kalero dance contains physics concepts that can be utilized as a learning resource. Some of the physics concepts identified include sound, GLB, centripetal force, air resistance, center of mass, moment of inertia, and vertical downward motion. Utilization of local wisdom as a learning resource can help students learn physics concepts contextually and improve critical thinking skills. In addition, it can foster a love for regional culture.

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