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Ethnophysics Study of the Concept of Work and Energy in the Aceh Traditional Game "*Taloe Yeye*" as Physics Teaching Material

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Abstract

Local wisdom is a form of human behavior and its relation with the surrounding environment, which is formed naturally and is sourced from customs and ancestral advice. The traditional game of *taloe yeye* is one of the many traditional games in Indonesia that needs to be preserved. In the *taloe yeye* game, physics concepts can be integrated into physics learning, one of which is work and energy. The purpose to be achieved from this research is to examine the ethnophysics of the concept of work and energy in the traditional Aceh game *taloe yeye*, which is expected to be used as physics teaching material. This study uses a qualitative descriptive research method. Data collection is done by observation and documentation. The data that has been collected is then analyzed using data analysis in stages, namely, reducing the observed data, presenting the data in the form of graphics and descriptive text, and drawing conclusions. The results showed a relationship between *taloe yeye* players and the concepts of work and energy. From this concept, students can experience actual learning by studying the physics of work and energy concepts in the *taloe yeye* game.

Keywords: Mechanical Energy; Physics Teaching Materials; *Taloe Yeye*; Work

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INTRODUCTION

Local wisdom is the result of certain groups/ethnic groups through the experience of local communities and does not have to be experienced by other communities. Local wisdom is very attached to certain groups/ethnic groups because the value of local wisdom has been tested and through a long process, even the age is almost the same as the existence of certain groups or ethnic groups (Hartanto et al., 2021; Meifisya et al., 2020; Sumiati, 2017). Local wisdom is a form of human behavior connected with the surrounding environment and is formed naturally and sourced from ancestors (Kurniasari et al., 2020; Susiati et al., 2020; Vitasura, 2016).

In general, local wisdom appears through a long internalization process and has been reduced from generation to generation due to the interaction between

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humans and their environment. The long process of developing evolutionary value causes the formation of a value system that is criticized in the form of the customary law of local communities and trust (Thaniah & Diliarosta, 2020).

Local wisdom is a way and practice by a group that comes from a deep understanding of the local environment passed down from generation to generation (Atiqah & Deskarina, 2020; Darmadi, 2018; Susanto et al., 2022). Along with the times and technology, local wisdom begins to fade and is at risk of being lost because it is considered different between local science and science. Even though local wisdom has lessons that can be emulated and developed into learning physics at school (Fitriah et al., 2021; Hartini et al., 2018; Laili & Hariastuti, 2020; Wati et al., 2019). One of the local wisdom that can be integrated into learning physics at school is traditional games.

Traditional games are an element of local culture often found in various parts of the archipelago and are common in rural communities. Traditional games are not only centered on playing but can significantly influence psychological development, character, and social life (Bramantyo & Tjaroko, 2022; Fuad et al., 2019; Misbah & Fuad, 2019). This is because traditional games contain elements of sportsmanship, accuracy, honesty, agility, and the ability to work in groups.

Traditional games have many benefits, namely being able to train children's creativity, being able to control emotions, and social intelligence, bringing children closer to nature, being able to develop children's motor skills, beneficial for training health, honing children's sensitivity, and so on (Hasanah, 2018). In addition to the many benefits that exist in traditional games, it turns out that there are also concepts in general learning, such as science. The concepts contained in traditional games can make it easier for teachers to convey learning to students. This integration can be used in learning, so studying the philosophy, game techniques, and rules that apply first is necessary.

The concepts contained in traditional games can make it easier for teachers to convey learning to students (Wati et al., 2017; Fuad et al., 2019). What is happening now is that teachers tend to use the lecture method in learning. Teachers should pay attention to this to evaluate their teaching methods (Makhmudah et al., 2019).

The facts of learning are now not in line with the 2013 curriculum objectives that use the scientific approach (Makhmudah et al., 2019). The scientific approach requires students to understand science from the surrounding environment. However, the teacher only provides general examples or even rarely known ones to students, and learning is limited to memorization (Rosita et al., 2019). As a result, students are less sensitive to events in the surrounding environment, even though they have links to physics.

Physics is a part of natural science that explains the observed phenomenon based on rational thinking, human experience, and experiments. Physics can be declared very close to everyday life. Because traditional games contain many physical concepts that can be analyzed and follow the competency standards of graduates, it is necessary to integrate them into physics learning at school.

Traditional games can be a consideration for teachers to develop into teaching materials. Using traditional games as teaching materials can also save the existence of traditional games that are currently rarely played (Kamid et al., 2022; Sholahuddin & Admoko, 2021; Yuberti et al., 2022). One of the

traditional games that can be used in learning is *taloe yeye*.

The traditional game of *taloe yeye* is one of the many traditional games in Indonesia that needs to be preserved. The *taloe yeye* game is often referred to as the jump rope game. In the past, the game *taloe yeye* was very much loved by children, but now it is very unfortunate because the development of a very traditional era has made this game forgotten by children and has even been replaced by games on cell phones. However, when adapted to the learning in school, it is hoped that the children will remember and protect the legacy, one of which is culture traditional games (Nurmasyitah et al., 2022). In the *taloe yeye* game, physics concepts can be integrated into physics learning, one of which is work and energy. Based on these problems, the purpose to be achieved from this research is to examine the ethnophysics of the concept of work and energy in the traditional Aceh game *taloe yeye*, which is expected to be used as physics teaching material.

METHOD

This type of research is descriptive qualitative. Qualitative research methods are a form of procedure in research that can produce descriptive data both orally and in writing and the observed behavior of research subjects (Jefriyanto, 2022). This method describes, explains, and analyzes the physics concepts found in *taloe yeye* players.

The data collection method was carried out by observation and documentation in Langsa, Aceh. Observations were made directly in the field by observing 3 *taloe yeye* players according to the research variables. Variables that affect these players include the mass of players. *Taloe yeye* players were chosen because they can explain the phenomenon and how to play *taloe yeye*. Documentation activities carried out during observation are used as visual research data.

The research design flow can be seen in Figure 1.

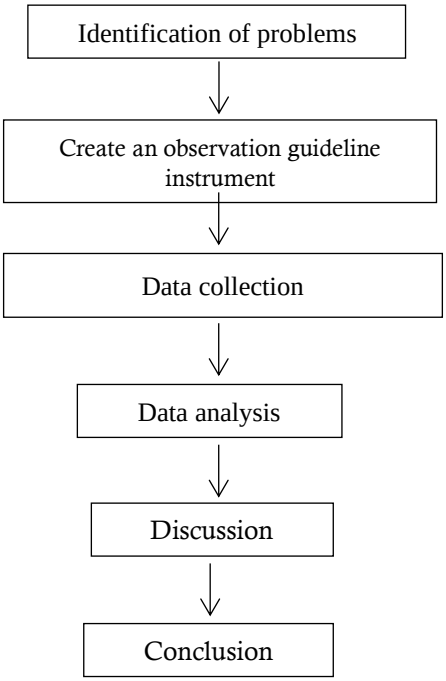

Figure 1 Research flow

The research instrument used in this study is an observation guide. Observation guidelines contain descriptions of activities to be observed in *taloe yeye* players.

The data that has been collected then analyzed in stages, namely, reducing the observed data, presenting the data in the form of graphics and descriptive text, and drawing conclusions.

RESULT AND DISCUSSION

This study uses three different player masses, namely 43 kg, 53 kg, and 63 kg. The maximum jump height of the players is measured manually using a measuring tape. The research results were obtained from examining the concept of work and energy generated by jump rope players

using different masses. For a *taloe yeye* player with a mass of 43 kg and a maximum height of 0.08 meters, the work obtained by 10 jumps is 127.68 Joules. The work obtained during 15 jumps is 157.79 Joules. Then, at 20 jumps, a business of 162.44 Joules is generated. Then, when there are 25 jumps, a work of 175.56 Joules is generated. And when 30 jumps, it generates a work of 181.89 Joules. The graph of time relation and player jump velocity is shown in Figure 2.

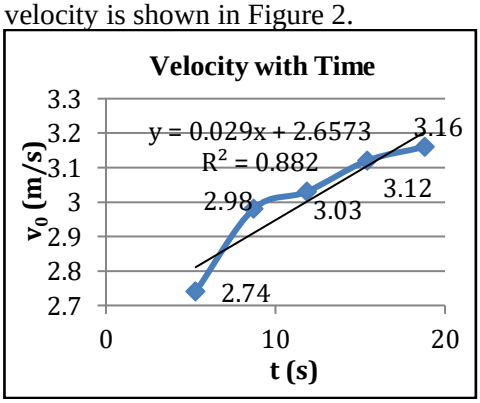

Figure 2 Graph of time relation and player jump velocity

Based on the graph presented in Figure 2, it is obtained from a regression analysis of a mass of 43 kg that there is a relation between velocity and time, which means that the greater the velocity, the longer the time to jump. When viewed from the correlation value R^2 = 0.882, there is a very strong relation between velocity and time.

For players jumping rope with a time of 10 seconds, a height of 0.08 m, and a different mass, data is obtained; when the player's mass is 43 kg, it takes 112.74 Joules of work to produce 20 jumps, when a player with a mass of 53 kg produces 18 increases, work is needed of 178.24 Joules, and when a player with a mass of 63 kg makes 15 jumps a work of 314.74 Joules is required.

Based on the graph presented in Figure 3, it is obtained from a regression analysis of jumps for 10 seconds that there is a relation between mass and the number of jumps, which means that the greater the mass of the players, the smaller the number of jumps of the players. When viewed from the correlation value R^2 = 0.9868, then there is a very strong relation between the mass of the players and the number of jumps. The graph of the relation between the number of jumps and the mass of players is shown in Figure 3, and the graph of player mass relation with work is shown in Figure 4.

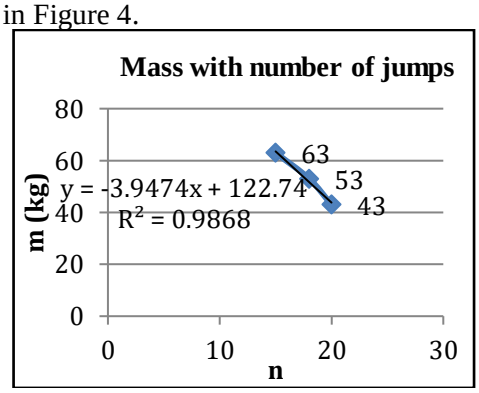

Figure 3 Graph of the relation between the number of jumps and the mass of players

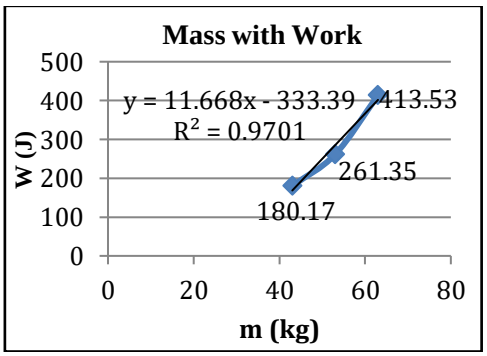

Figure 4 Graph of player mass relation with work

Based on the graph presented in the figure, it is obtained from a regression analysis of the jump for 10 seconds that there is a relation between the mass of the players and the work, which means that the greater the mass of the players, the greater the work produced. When viewed from the correlation value R^2 = 0.9701,

there is a very strong relation between mass and work.

When the number of player jumps is determined to be ten jumps with different masses, it is obtained that when a player with a mass of 43 jumps, the time required is 5.30 seconds, and the work generated is 128.63. When the player's mass is 53 kg, he makes ten jumps, the time needed is 5.48 seconds and requires a work of 170.67 Joules. Moreover, when a player with a mass of 63 kg does ten jumps, the time needed is 6.06 seconds and requires a work of 253.59 Joules.

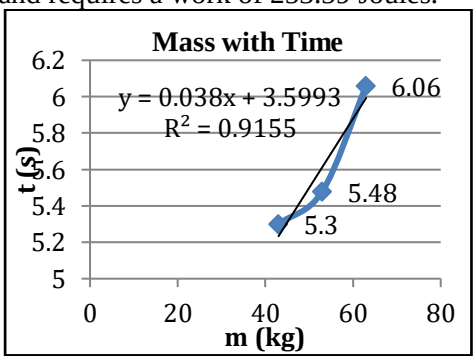

Figure 5 Graph of player mass relation with jump time

Based on the graph presented in Figure 5, a regression analysis is obtained from the number of jumps ten times; there is a relation between the mass of the players and the time obtained, which means that the greater the mass of the players, the greater the time needed to make the jump. When viewed from the correlation value $R^2 = 0.9155$, there is a very strong relation between mass and time.

The *taloe yeye* game is shown in Figure 6.

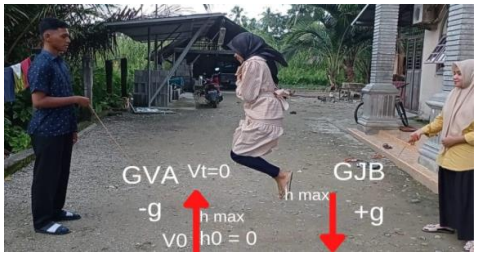

Figure 6 The *taloe yeye*

Rosmaradhana et al. (2020) state that traditional games are a hereditary legacy in which there is education and Indonesian culture. *Taloe yeye* is a traditional game that uses rubber bands that are tied together to form a rope. This game has been around since the Dutch colonial era and was played by Dutch children until it spread to various parts of Indonesia with different names.

This study aims to determine the physics concept in *taloe yeye* players, especially work and energy. The research results are the concepts of work and energy physics in *taloe yeye* pens, which can be used as physics learning materials.

From the research results, it can be seen that the movements of the *taloe yeye* player are included in the vertical upward and free-fall motion. This is because when the player jumps at the initial velocity (v_0), the player's velocity will decrease until it reaches the maximum height (h), so the final velocity becomes zero. This is in line with the theory of vertical motion, where the initial velocity is not equal to zero ($v_0 \neq 0$). Then when it reaches the maximum height, the *taloe yeye* player will move down due to the force of gravity. This is what causes the *taloe yeye* player to do a free fall when he is in the lower position because when he is in the highest position, the player's velocity becomes zero.

When the *taloe yeye* player is in the up position, the acceleration due to gravity becomes negative because it is opposite the direction of the gravitational force. Meanwhile, when the *taloe yeye* player is in the down position, the acceleration due to gravity becomes positive because it is in the same direction as the force of gravity.

When the *taloe yeye* player makes a jumping motion, there is work made by the player. The work of the *taloyeye* player depends on the kinetic energy and

potential energy of the *taloe yeye* player. The potential energy of the *taloe yeye* player is due to the height of the jump, while the player's kinetic energy depends on the velocity of the player's jump.

When the *taloe yeye* player jumps, there are two mechanical energies, where mechanical energy 1 is when the player's position is about to jump. Mechanical energy 2 is when the player's position reaches the maximum height.

When the *taloe yeye* player is about to jump, which means the player is still touching the ground, the ball does not have a height, so the player's potential energy becomes zero. However, the *taloe yeye* player has a velocity of *v*, so the kinetic energy of the *taloe yeye* player has a value of $Ek = \frac{1}{2}mv^2$. Therefore the mechanical energy of 1 *taloe yeye* player is $EM_1 = \frac{1}{2}mv^2$.

When the *taloe yeye* player reaches the maximum height, the *talo yeye* player has a height of h, so the player has a potential energy of Ep = m. g. h, but the player's maximum velocity becomes zero, so the player's kinetic energy becomes zero. So, the mechanical energy of 2 *taloe yeye* players is $EM_2 = m.g.h$.

From these two statements, it can be formulated that the work on the *taloe yeye* player is:

$$W = (m.g.h) - (\frac{1}{2}mv^2)$$

From this equation, it can be concluded that the amount of work depends on the potential energy of the player when he is at the maximum height and the kinetic energy of the player when he is about to jump. In other words, work depends on the player's height, player's mass, and player's velocity.

From the research that has been done, the potential energy of the *taloe yeye* player depends on the mass and height of the player. This research is in line with Rumiati's research (2021) that the greater the mass and position of an object, the greater the potential energy contained in the object. The potential energy in physics depends on the mass and height of the object.

In this study, it can also be concluded that the kinetic energy possessed by the *taloe yeye* player depends on the velocity and mass of the *taloe yeye* player. This is following Kalhor's research (2020) that increasing kinetic energy requires a certain particle work and velocity. Then Surabidin's research (2019) shows that the greater the mass of an object, the greater the kinetic energy produced. Kinetic energy in physics, depends on the mass and velocity of objects.

Based on the work concept described above, it turns out that it follows the third form of energy work theorem by Abdullah (2016) that the work done by non-conservative forces is equal to the change in the object's mechanical energy. Mechanical energy depends on the amount of kinetic energy and potential energy of objects.

Based on the ethnophysics study that has been carried out, the physics concept in taloe yeye players can be implemented into physics learning under the basic competencies based on K13, which are presented in the following Table 1.

Table 1 Relationship between the physics concepts of *taloe yeye* players with basic competencies K13

The concept of physics in the *taloe yeye* players	**Basic Competencies K13**
Work and Energy	3.9 Analyzing the concept of work, energy, work relation, and energy changes, the law of the conservation of energy, and its application in everyday life.

The concept of physics in the *taloe yeye* players	Basic Competencies K13
	4.9 Applying the scientific method to propose ideas for solving motion in everyday life related to the concepts of work, energy, and the law of energy conservation.

The existence of ethnophysics can combine local wisdom with the concept of physics that exist. Thus students can understand a concept of physics through local wisdom that exists become easier. According to Astuti & Bhakti (2021), the application of ethnophysics learning has the potential to develop learning methods that are generally centered on teachers to be learning centered on students. This makes the class atmosphere more enjoyable and not boring, increasing student learning spirit. In addition to understanding the concept of physics, students can also learn to understand local wisdom in the area so that the culture does not fade and can continue to be preserved (Munandar et al., 2022).

In Husin (2018), research in the integration of local wisdom in the form of teaching materials is easier to understand students, making it easier for students to communicate the concepts learned about what is in their environment and as guidelines for teachers in conducting learning processes in class. And the study by Anggramayeni (2018) found that local wisdom-based teaching materials effectively increase students' learning outcomes.

The *taloe yeye* game can be used as a physics teaching material in studying the concepts of work and energy. Teaching materials support the level of learning development in students by practicing and implementing it in physics studies (Astuti et al., 2022). Physics teaching materials because they can visualize a real learning process and can be used in physics learning.

CONCLUSION

Based on the results and discussion above, it can be concluded that the game of *taloe yeye* is a local wisdom from Aceh. This game is played by jumping over a rope. In *taloe yeye* players there are physics concepts such as work and energy. The work of the *taloe yeye* player is influenced by the mass of the player, the height of the jump, and the velocity of the player's jump. From this concept, students can experience actual learning by studying the physics of work and energy concepts in the talo yeye game.

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