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# STUDY OF THE CONCEPT OF MOVEMENT DYNAMICS BASED ON ETHNOPHYSICS IN THE TANGGAI DANCE

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**ABSTRACT**

Culture in Indonesia is known to be very diverse, which has not been explored to its full potential due to limited access and minimal awareness of resources in preserving it. Physics learning is often still teacher centered with students becoming uncertain and feeling bored because they think this learning is only based on formulas. So local wisdom is needed with physics learning to implement the concept of movement dynamics with an ethnophysical approach by involving phenomena in students' daily lives to more easily understand learning. Regional dances are one of the local wisdoms that have direct contact with students at school, one of which is the Palembang regional dance, namely the Tanggai dance. This research aims to identify studies of the concept of movement dynamics in movements in the Tanggai Palembang dance. This type of research uses descriptive qualitative with a documentation study approach and the object of this research is the Tanggai dance. Data was collected using two methods, namely the training video analysis method and literature study and the observation method. The results of the research were a study of the concept of movement dynamics in each movement of the Tanggai Palembang dance, especially on the material of Newton's law when changing positions in each movement, moments of force and circular motion in rotating hand swings, conditions for equilibrium of rigid bodies, frictional forces on the legs when walking, and changes in points dancer weight. The ethnophysical approach has the potential to be an innovation in physics learning because it is able to train students scientific literacy to think critically through culture that is integrated into knowledge.



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## 1. INTRODUCTION

Physics is a science that allows us to investigate and understand the fundamentals of the universe. Physics is stated to be the stem of science that supports various discoveries, advances in technology and other sciences. In studying physics, the ability to master basic concepts is very necessary (Kurniawati & Nita, 2018). This is because physics learning is not focused on memorization alone, which is only enough to read at a glance. However, physics learning really

needs to be implemented into various problems that exist around us (Ayudha & Setyarsih, 2021). Physics is often considered a subject that tends to be boring and makes students find it difficult to learn because current learning is still closely tied to rigid guidebooks (Fathurohman, 2014). Indirectly, it provides a negative stigma which causes students interest to decrease in understanding physics further and has a big impact on low student learning outcomes. The current reality is that many students cannot be categorized as active or directly involved in the physics learning process, whether actively thinking or acting (Ginoga et al., 2023).

The strategy that can be implemented is to make a progressive change by providing brilliant ideas that can be applied to education in Indonesia by solving problems that surround the wider community by integrating local wisdom into physics learning. Local wisdom can be used as a model that is implemented in everyday life and content integrated with local wisdom aims to generate new and developing ideas (Wahyuni & Lia, 2020). Ethnophysics can be defined as learning activities that transform physics concepts with the culture or beliefs of local communities (Canticha, 2021). Learning with an ethnophysical approach is utilized so that students can more easily understand physics concepts through problem phenomena that exist in everyday life (Astuti et al., 2022). It is rare for physics lessons given to students to implement regional culture (Rahmadani, 2022). An educator is required to have the ability to combine scientific knowledge and indigenous knowledge. The implementation of learning using this approach is expected to be able to develop a more active and student-centered learning process.

Palembang is an area that has very diverse and still strong cultural diversity. Palembang's cultural richness is quite varied, including traditional clothing, traditional houses, types of dance and also regional specialties. However, in the world of education, efforts to explore culture are still very minimal, resulting in low knowledge of students as successors of traditional cultural diversity. According to Alimin (2018), there are still many typical Palembang cultures that have not been explored to their potential either in terms of pedagogy or content. In order to avoid the fading and loss of Palembang's original culture and the occurrence of cultural conflicts and clashes, efforts are needed to explore the original science of Palembang itself. One ethnophysics that can be developed in the wider community is through the Tanggai Palembang dance art.

The Tanggai Dance is one of Palembang's distinctive local wisdoms that has long been developed and holds even greater potential, but has not been thoroughly explored or introduced well due to the constant influx and change of foreign cultures into the local land itself (Despita et al., 2023). This dance is presented as a welcoming dance for the guest of honor, which has the characteristic of being performed by an odd number of female dancers dressed in accessories such as dodot, pending, necklaces, songket cloth, bun malang, potpourri or kembang urat, kembang goyang, henna cempako, and The ladder, which is the main characteristic, is shaped like a yellow nail and is made of steel plate (Hera, 2020). The Tanggai dance at several schools is taught to students through extracurricular dance arts with the hope that students can preserve Palembang's unique culture and also become teaching material and material at several universities in Palembang (Katungga & Syahrial, 2019).

Each movement of this dance is closely associated with the concept of dynamic motion, whether it's the balance of rigid objects or rotational dynamics in physics learning. This is in line with research conducted by Asbanu (2023), by analyzing the general physics concepts in the Okomama dance movements, students can use it as a physics learning resource. This is also confirmed by several studies that implement traditional regional culture into physics learning,

including by Nurhidayat et al., (2020) in his research analyzing the concept of heat in the Mojang Priangan dance movements and research Leni & Suripah (2023) by analyzing the physics concepts found in typical Kalimantan Dayak Chopsticks. Based on the description that has been described, the aim of this research is to analyze the Tanggai dance as a culture or local wisdom that can be integrated into the concept of movement dynamics in physics learning because no analysis of the Tanggai dance has been found in a similar context which can of course be adopted by educators in various cultural contexts and academics in fulfilling the implementation of movement dynamics teaching materials in schools.

## 2. METHOD

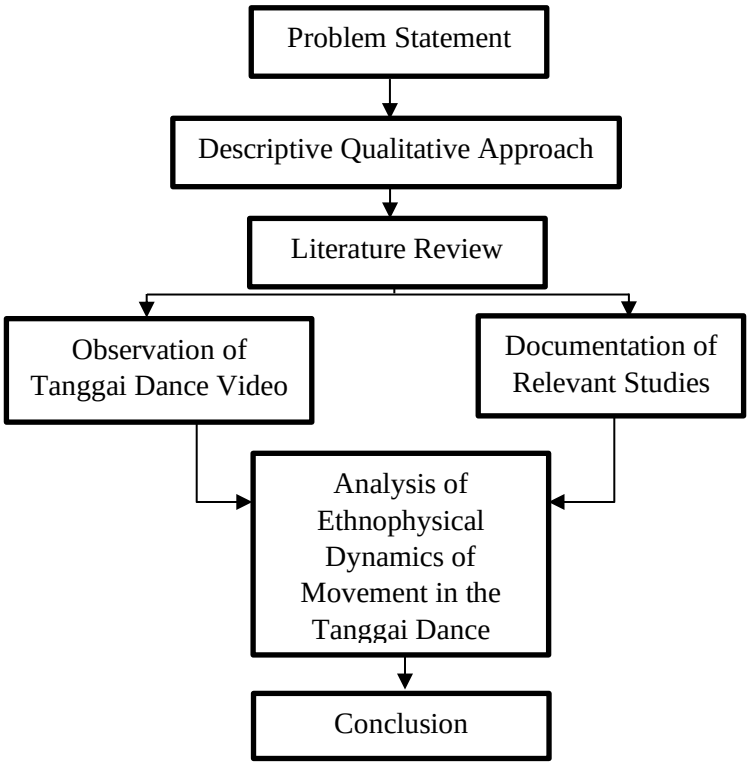



Figure 1. Research Procedure

The flowchart of the research procedure in this study is shown in Figure 1. This research is included in the method with a qualitative descriptive approach, namely literature study. A descriptive approach is a type of research aimed at describing phenomena that occur either engineered or naturally (Sugiyono, 2015:135). A qualitative descriptive approach was used to interpret events in the field. The research stages carried out were; collect information about the Tanggai Palembang dance culture, analyze the concept of relevant movement dynamics in the Tanggai Palembang dance along with its quantities, then present the data obtained and formulate the results of the study, and draw conclusions. In this research, the data collection method was carried out using the observation method which was used to dig up information about the Tanggai Palembang dance and analyze the concept of movement dynamics in each movement contained in the Tanggai dance. The data was analyzed using two integrated methods, namely observation analysis in the form of dance practice videos to study the concept of movement dynamics and also

analysis of information from several relevant literature studies related to research on Tanggai dance.

## 3. RESULTS AND DISCUSSION

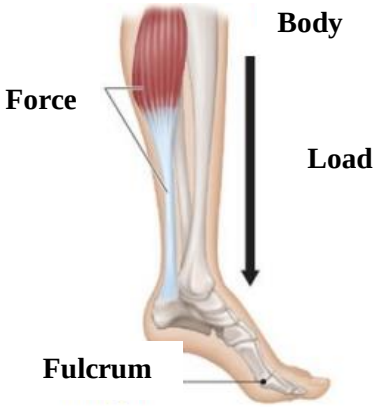
Physics learning is integrated into culture which is aimed at building reality by prioritizing the relationship between knowledge and culture from generation to generation. The Tanggai dance as shown in Figure 2 is a dance created by Elly Rudy for a special welcoming event for Palembang after the decline of the Gending Sriwijaya dance. This dance is often performed at several traditional and formal events, including welcoming guests, weddings, art performances and so on. This dance is characterized by the characteristic yellow false nails used by dancers consisting of only eight fingers with a total weight of around 100 g. The complete attributes of this dance are decorated with typical Palembang clothes and a crown decoration on the head which is around 2-3 kg. In this research, the problem analysis only focuses on the concept of movement dynamics in the Tanggai dance movement. In this research, we will discuss identifying the concepts of movement dynamics contained in each of the Tanggai Palembang dance movements.

Figure 2. Dancers and attributes of the Tanggai Palembang dance

### 3.1. Newton's Law

The Tanggai dance movement begins with the dancer entering the arena accompanied by music with hand positions called the Borobudur movement which is interpreted as an effort to improve the quality of life towards success and is accompanied by prayer. The hands are placed in front of the chest and the standing position is in a row with the feet on tiptoes, the tip of the dancer's feet as in Figure 3 becomes the fulcrum with the aim of maintaining the balance of the dancer's body. So that the body is in balance, the legs are positioned parallel to the left and right.

The physics concept of standing on tiptoes also includes Newton's First Law, with the feet as support and the middle of the body as the center of gravity. This law states that if the dancer's position is still, it will remain still, and if the dancer moves, it will continue to move at a fixed or constant speed.




Figur 3. Schematic of a Tanggai dancer's feet when standing on tiptoe

$$\Sigma\vec{F} = 0 \quad (1)$$

$$W_1 + W_2 - N = 0 \quad (2)$$

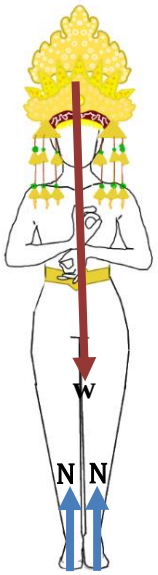



Figure 4. Illustration of the position of a Tanggai dancer entering on tiptoe

In this movement there is also the concept of Newton's Second Law, which states that:

$$\Sigma\vec{F} = m.\vec{a} \quad (3)$$

$$\vec{F} = m\,(\alpha.R) \quad (4)$$

$$\vec{F}r = m\alpha r^2 \quad (5)$$

$$\vec{\tau} = I.\alpha \quad (6)$$

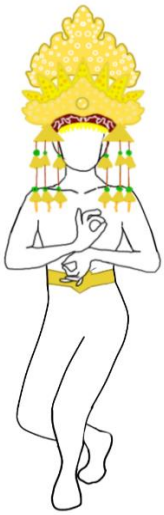


Figure 5. The position of the Borobudur praying dancers is standing

In this dance there is also Newton's Law III, with the position when the Tanggai dance dancer is standing in order to maintain the Aesan Gede crown in a balanced state, the force exerted by the headdress will put pressure on the dancer's head. The action force exerted by this crown presses the head and leads to the center of the earth, while the reaction force is obtained on the dancer's head which maintains balance while the dancer performs movements. Newton's Third Law can be stated to work if there is a force of the same magnitude but opposite direction and acting on different objects in the sense that this concept works on the crown of the dancer's headdress on the head of the Tanggai dancer.

$$\vec{F}_{action} = -\vec{F}_{reaction} \qquad (7)$$

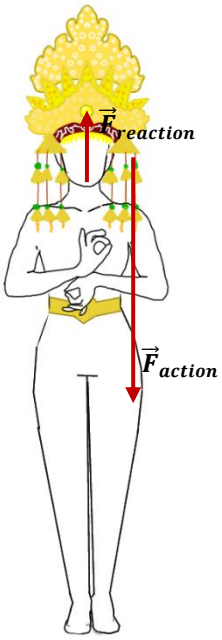



Figure 6. Illustration of action and reaction in Tanggai dance

### 3.2. Moment of Force and Circular Motion

In the Tanggai dance movements, hand swings are most often done whether sitting or standing. This movement is called the amethyst movement which is characterized by rotating hand swings. In this movement there is the concept of torque or moment of force. Torque is a physical quantity that measures the extent to which a force tends to twist or rotate an object around it. Torque can be thought of as a moment of force that acts on an object and can cause the object to rotate or bend around a certain point. When a point is perpendicular to the force, there is the potential for a moment of force to occur at that point. When the load is evenly distributed, it can be considered as a beam that is homogeneous with respect to the coordinates of its center of gravity. Because the center of gravity on the arm is always downwards due to the force of gravity, the moment arm can be determined.

$$\tau = F \times r \sin\theta \qquad (8)$$

Figure 7. The position of the circular amethyst movement is top right

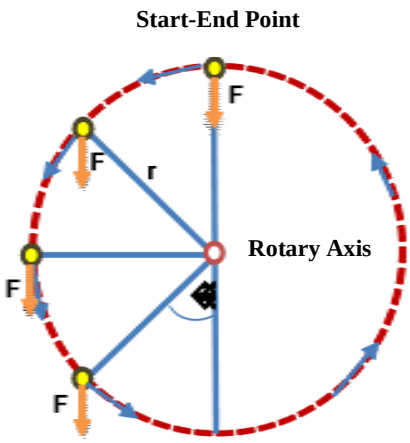



Figure 8. Diagram of the circular movement of a dancer's hand swing

### 3.3. Frictional Force

Frictional force is a force that acts on an object when it moves through or is in contact with a surface. When the dancer changes movements by swinging the body to the right and left after performing the Borobudur prayer, accompanied by the feet changing position while swinging while walking in place, it is called a doormat walk with the soles of the feet swinging alternately. In this mat walk, the position of the feet when they are still is lifted and swung forward and pushed to the floor so that the surface of the feet touches the floor. In this movement there is a kinetic friction force which is characterized by the friction force acting on two dynamic surfaces that move and rub against each other.

$$f_k = \mu_k . N \tag{9}$$

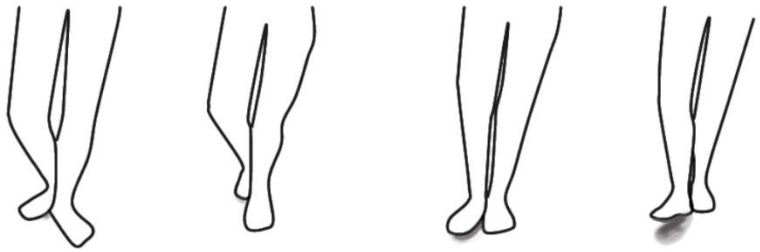


Figure 9. The position of the dancer's feet during the mat movement

### 3.4. Center of Gravity

The center of gravity of a body is a hypothetical point where the entire weight (or mass) of an object or system of objects is concentrated. This is the point at which the force of gravity can be considered to act on a body or system of bodies as a whole. The body's center of gravity is a concept used in various contexts, especially in physics and engineering. It is important to understand that the body's center of gravity does not always have to be on the object itself; in some cases, the body's center of gravity may be outside the object, especially if the object has an uneven shape or mass distribution. For homogeneous objects (objects with uniform density), the body's center of gravity will be right in the middle of the object. However, for objects that have uneven mass distribution or complex shapes, determining the location of the body's center of gravity may be more complicated. Essentially, a body's center of gravity allows us to treat an entire object as a single point of mass when analyzing the movements and physical reactions acting on that object. Body balance is influenced by the location of the body's center of gravity. Determining the location of the center of gravity of more complex objects can require calculations involving the mass of each part of the object and its distance from a reference point. When the dancer changes position from standing upright to a lowered position to take a sitting position or what can be called a thread stretching movement, there is a shift in the dancer's center of gravity from initially being in the middle to slightly rising towards the chest. This shift in the center of gravity always changes depending on the dancer's position until they are sitting. The thread stretching movement itself

describes the activities of Palembang women whose daily work is related to weaving or embroidery, so it is directly related to thread and rope.

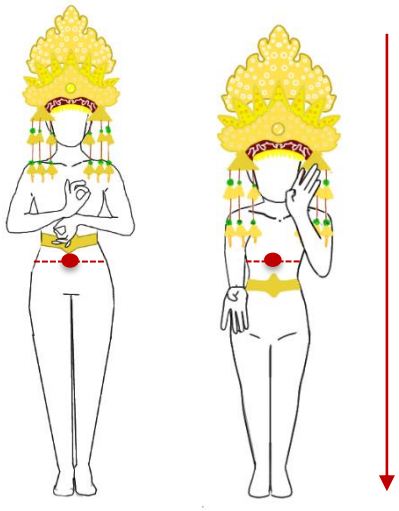


Figure 10. The dancer's position experiences a shift in the center of gravity

### 3.5. Equilibrium of a Rigid Body

The first movement is a mendak movement with the hands forming a borobudur and the legs crossed backwards followed by the body dropping low with the shoulders remaining straight and not leaning forward or backward. In this position, the dancer's movements can only lean to the left and right. Dancers use the middle of the body as the center of mass with both legs fighting to support the body weight. The condition of the chest is tilted forward, and the shoulder blades are slightly pulled back, giving the impression of being sturdy. It can be defined as the resistance force of the force. When the dancer is moving, the crossed legs must be in a strong position to gather more power in the thighs.

Figure 11. Crossed leg position when climbing

In the sitting prayer movement there is also a principle of balance which can occur if the gravity and fulcrum are on the same line. If the dancer's position is not in line with the fulcrum, the dancer will experience an imbalance, so that if the slope exceeds 70°, the dancer will fall backwards because the fulcrum cannot maintain a balanced position. This Tanggai dance can be categorized as stable or balanced, namely:

$$\Sigma F_x = 0 \qquad (10)$$

$$\Sigma F_y = 0 \quad (11)$$

$$\Sigma \tau = 0 \quad (12)$$

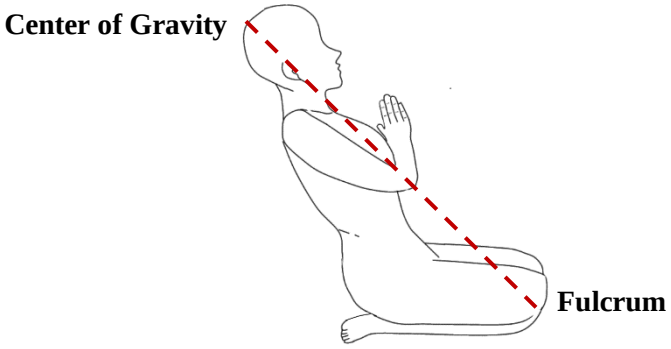



Figure 12. The position of the dancer is to perform a sitting prayer movement

## 4. CONCLUSION

Based on the results and discussion provided, it is evident that the movements performed in the Tanggai dance, representing one of Palembang's local wisdoms, can be analyzed using concepts from physics. Various principles of movement dynamics such as Newton's laws, moment of force, and circular motion are exemplified in the dance's movements, including the clockwise swing of the arms, the kinetic friction force during stationary walking, and the manipulation of the body's center of gravity for balance. Integrating Tanggai dance into physics education not only enlivens the classroom atmosphere but also encourages students to observe and analyze real-world phenomena, fostering problem-solving skills. Ethnophysics, as demonstrated in this study, serves to introduce Palembang's cultural heritage while enhancing understanding of physics concepts. Future research endeavors could explore additional physical concepts within Tanggai dance or other local wisdoms, further enriching educational resources and deepening students' comprehension of motion dynamics.

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