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Physics Concepts Analysis in the Traditional Games of *Kekehan*

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Abstract

Indonesia has an enormous amount of diversity, and unconsciously every culture has a different attraction. In its own culture, there is a science of physics that few people know much about, but local wisdom from several different areas can be used as a source of study in physics, one of which is traditional kekehan games. The study aims to understand the concept of physics in the traditional games of kekehan. The research method used in this study is qualitative descriptive methods. The approach used in this study is the ethnographic approach. The data collection method used is observation, documentation, and literature study. Observation and documentation are done in the physics education program at surabaya state university. From observation, documenting and literature studies, it can be concluded that mass influences the acceleration of the hostility Angle, where it inverse to angular acceleration. The second experiment showed that the fingers affect the rotation time. And it can also be discovered that the square of the finger is comparable to the kinetic energy rotation. The concept of physics of inertia includes moments of inertia, angles, heavy forces, circular motion, torque, and style moments.

Keywords: *kekehan*, physics, local wisdom

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INTRODUCTION

Indonesia exhibits a remarkable degree of diversity, wherein each distinct culture possesses unique and distinct characteristics that contribute to its individual allure. It can be argued that every region possesses a unique cultural value that distinguishes it from others. Preservation and advancement of cultural diversity can be achieved through education while upholding the esteemed values of the nation. According to Mulyasa (2015), culture is considered to be a significant manifestation of local wisdom, serving as a defining characteristic of a particular geographical area. Local wisdom refers to the customary practices and knowledge that are commonly observed and implemented by local communities (Kun, 2013; Njatrijani, 2018). Ethnophysics refers to the study of indigenous physics principles derived from local knowledge and wisdom (Suprapto et al., 2021; Wulansari et al., 2021; Satriawan et al., 2016). In the field of physics, proficiency in observation, manipulation, and quantification is imperative. Additionally, the ability to engage in critical thinking plays a crucial role in effectively addressing and resolving complex problems. (Astuti et al., 2022; Nugraha et al., 2023).

The primary emphasis in physics education lies in the cognitive domain, which tends to overlook the comprehensive nature of physics encompassing processes, products, and attitudes. Therefore, the application of physics in daily life is imperative in order to optimize the veracity of physics (Nurmasyitah et al., 2022).

The acquisition of substantial knowledge can be achieved through the application of contextual learning principles, as demonstrated by Lestari et al. (2022) and Sari et al. (2019). Within a particular cultural context, there exists a scientific discipline that remains relatively unfamiliar to the general populace. Furthermore, indigenous knowledge originating from diverse regions can serve as a valuable resource for acquiring knowledge in the realm of physics (Wulansari, 2021; Putri, 2017).

Physics, particularly the field of physics, exhibits a strong correlation with natural phenomena that are grounded in empirical observations and verifiable evidence. According to Putra (2022), the learning resources encompass various mediums such as books, handouts, games, and other similar materials. Games serve as a valuable learning resource for students, effectively capturing their interest and fostering engagement in the educational process. Indonesia boasts a rich diversity of traditional games, among which the game of *kekehan* or *kekehan* holds prominence. According to Astuti (2021), the object in question is a conventional plaything that possesses the ability to rotate around a central axis and maintain equilibrium. The term "gang" refers to a corridor or a specific area of land, whereas "sing" denotes the act of producing vocal sounds. In its most basic form, the term "*kekehan*" refers to a recreational activity that involves playing a game within a vacant setting, accompanied by the production of auditory vibrations. According to sociological research, it has been determined that the game of *kekehan* can be traced back to its origins in China, where it gained significant popularity during the reign of the Ming Dynasty.

The concept of physics is closely associated with the phenomenon of *kekehan*. As an illustration, let us consider the dynamics of rotational motion, specifically the interplay between torque and angular momentum. This concept enhances the process of learning and appeals to students' engagement in education, as the utilization of games in learning has been found to facilitate comprehension and retention among students. The traditional game of *kekehan* has its origins in the Betawi culture, specifically in the region of DKI Jakarta. Wooden materials have historically been utilized in the creation of traditional games, wherein they are meticulously carved and shaped to form various components of the *kekehan* structure. When the activity of *kekehan* is initiated, it results in the generation of a phenomenon known as the gyroscopic effect (Febriyanti et al., 2018; Syahda et al., 2022). The top-like object underwent rotational motion, causing the leg portion to align vertically with the body of the top. Following a period of vertical rotation, the angular momentum and gyroscopic effect gradually diminished until the rotating object ultimately descended to the ground and ceased its rotational motion.

The game of *kekehan* originated from its predecessors and quickly disseminated to numerous nations, encompassing Latin America, Africa, and Southeast Asia, notably Indonesia. The proliferation of violence in Indonesia can be attributed to the influx of Chinese immigrants and merchants. According to Arikunto (2005), various nations engage in enculturation or cultural adaptation, wherein they incorporate and develop local wisdom from each region while preserving the original elements. The practice in question has been observed since the era of the ancient imperial civilization in the region of Java, dating back to the 13th century. Over time, it has disseminated to diverse regions within Indonesia, assuming distinct designations. In the eastern region of Java, the game is commonly referred to as "*Kekehan*," which translates to "*akeh-akehan mumet*" denoting a high frequency of rotation. In central Java, the game is crafted using bamboo and is known as "*Gangsingan*," while the wooden variant is called "Pathon." In the islands of Riau and Tanjung Pinang, the game is referred to as "*Kekehan*." In western Java and DKI Jakarta, it is known as "*Panggal*." In eastern Kalimantan, the game is called "*Begangsing*," and so forth (Saprima et al. 2020).

At the onset, there was a notable increase in poverty within rural communities, with farmers being particularly affected. In the context of a predominantly agrarian society, farmers require recreational outlets to foster and sustain social connections within their local community. Similar to a game that evolves and matures within the confines of a limited tradition, this particular type of game does not undergo significant innovation in terms of its rules, structure, or design. Various types of *kekehan* exist that vary depending on their respective domains. There are gaseous substances that exhibit elongated spherical shapes, as well as others that resemble the anatomical structure of a heart. Additionally, there exist gaseous formations that exhibit knot-like, cylindrical, and even flying dish shapes. There exist various types of *kekehan*, including those derived from bamboo, wood, and plastic materials. It is imperative to acknowledge that the dimensions of the object vary, resulting in distinct diameters contingent upon the specific preference.

Typically, the coloration of the *kekehan* is determined by the preferences of the manufacturer or tailored to meet the specific demands of the purchaser. The application of a thicker layer of paint can be achieved through the use of wooden paint or colored pencils and markers. The purpose of assigning a color to a square is to establish a visual differentiation between two distinct players. A minimum density of two colors is required, which should exhibit a contrasting, aesthetically pleasing, and appealing match. The color of the chest can be applied to the waist, chest area, head, or the entirety of the chest (Larasati, 2011).

METHOD

The research methodology employed in this study is the qualitative-descriptive method. According to Firdiani et al. (2019), the methodology employed in this research study is an ethnographic approach. The objective of employing the ethnographic approach is to critically examine and document the conceptual underpinnings of physics inherent in the traditional game. According to Rumiati et al. (2021), the focus of this study pertains to the examination of the existence and physical principles governing the equilibrium of solid objects within the conventional framework of the game of rigidity.

The data collection methods employed in this study encompass observation, documentation, and literary analysis techniques. The Education Physics Department of the State University of Surabaya conducted observations and documentation. The method of observation entails engaging in the game firsthand, wherein one directs their attention towards the research variables. The variables employed in this study encompass the number of *kekehan*, their respective masses of *kekehan*, and the types of *kekehan*. The response variables of this experiment are time and angular velocity. The resulting time from the kekehan is thrown until the kekehan stops. Meanwhile, the angular velocity is measured from the kekehan being thrown until the kekehan reaches the equilibrium point using a tachometer. The implementation involved conducting observations and documentation to enhance the elucidation of the physical principles underlying rotational dynamics.

RESULTS AND DISCUSSION

Kekehan

The *kekehan* in question possesses the ability to rotate around its axle and maintain equilibrium at a specific location. The game of rigour, or rigour, is inherently interconnected with the fundamental principles of physics that govern various aspects of our daily existence. A *kekehan* is defined as an object that maintains its shape and volume without undergoing any deformation or alteration when subjected to external forces or influences. Consequently, when in motion, a *kekehan* retains its original shape and volume without experiencing any changes. The field of rotation dynamics investigates the rotational motion by examining the underlying cause, which is the moment of inertia. Rotational motion is attributed to an object when every constituent part of said object undergoes movement around a designated axis or axes of rotation (Saprima et al., 2020). The data collection methods employed in this study encompass observation, documentation, and literary study techniques. The Education Physics Program of State University of Surabaya conducted observations and documentation. The process of observation entails engaging in the game firsthand, wherein one directs their attention towards the variables under investigation. The variables employed in this study encompass the number of fingers, their mass, and their specific type. During the execution of the experiment, the process of documenting observations was conducted in order to enhance the explication of the physical principles pertaining to rotational dynamics.

A torque refers to a scalar quantity capable of inducing rotational motion in a particle. In the present scenario, the argument exhibits circular reasoning. According to the principles of torque, the radial distance between the axis of rotation and the rotating object's outermost point affects the magnitude of the rotational velocity. As the distance increases, the rotational speed decreases, resulting in a reduction in velocity. The torsional behavior of a system is not only affected by the distance between the rotational axis and the outermost rotational speed, but also by the magnitude of the vertically directed force applied to the rotary axis. The magnitude of the applied force directly affects the resulting torque, leading to an increase in speed when a stronger force is exerted. Conversely, a decrease in force results in a slower speed. The speed of angle rotation is influenced not only by the angle factor and the fingers, but also by the mass of the angles. The study of rotation dynamics involves the application of Newton's second law to establish the correlation between torque and angular acceleration.

$$\tau = I.\alpha \tag{1}$$

Where τ is the total torque exerted on the object, and I is the moment of inertia of the object, so:

$$\alpha = \frac{\tau}{I} \tag{2}$$

Moment of inertia I of regular body is given as $I = mr^2$, where m is its mass and r is the radius of the circular path of ration. The mass of *Kekehan* is measured with Ohaus Balance as seen in Figure 1.

$$I \propto m \quad (3)$$

Therefore:

$$\alpha \propto \frac{\tau}{m} \quad (4)$$

(a) (b)

Figure 1. Mass of (a) Bamboo *Kekehan* and (b) Wooden *Kekehan*

The *kekehan* possesses the ability to undergo rotational motion, thereby exhibiting rotation. Both the magnitude of the rotation itself and the length of the arm have an impact on the rotational motion's magnitude. The relationship between the three factors can be expressed by Equation 5.

$$\tau = r \times F$$
$$\tau = r\,F\,sin\theta \quad (5)$$

Like the F force, the τ torsi also includes vector sizes, which have a major and a direction. The difference is that there are only two torque directions, either in the same or opposite direction of the clock needle. These two torsion directions are quite distinct by giving a positive signal (couter clockwise) or negative (clockwise). In order to be consistent with the mathematical rules and the directional rules of angular momentum and the Lorentz style (Adrianto et al., 2006).

Physics Concepts in *Kekehan*

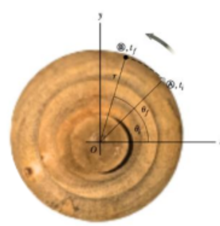

Figure 2. Particle Motion in *Kekehan*

When the particle in the *kekehan* moves from position (A) to position (B) in the time interval Δt as in Figure 2, then the reference line attached to the object forms an angle $\Delta\theta$. The quantity $\Delta\theta$ is defined as the angular displacement of a rigid body:

$$\Delta\theta = \theta_f - \theta_i \quad (6)$$

The speed at which this angular displacement occurs can vary. If the chortle rotates rapidly, the displacement may occur within a short time interval. If it rotates slowly, this displacement occurs over a longer time interval.

These different rotation rates can be calculated by determining the average angular velocity ω_{avg} as the ratio of the angular displacement of a rigid body to the time interval Δt during which the displacement occurred:

$$\omega_{avg} = \frac{\theta_f - \theta_i}{t_f - t_i} = \frac{\Delta\theta}{\Delta t} \tag{7}$$

In the translational velocity analogy, the instantaneous angular velocity ω is defined as the limit of the average angular velocity as Δt approaches zero, so that:

$$\omega = \lim_{\Delta t \to 0} \frac{\Delta\theta}{\Delta t} = \frac{d\theta}{dt} \tag{8}$$

The value of ω becomes positive when θ increases (counter clockwise movement) and negative when θ decreases (clockwise movement).

Based on the observations that have been made, there are there types of *kekehan* that were tested: wooden *kekehan*, bamboo *kekehan*, and plastic *kekehan*. In this type of bamboo, there are two different diameters, namely (4.5 and 5.5) cm. Meanwhile, in wood *kekehan*, there are 2 different diameters, namely (2 and 6) cm. From the observations made in Figure 3, it can be seen that the grip radius influences the angular velocity.

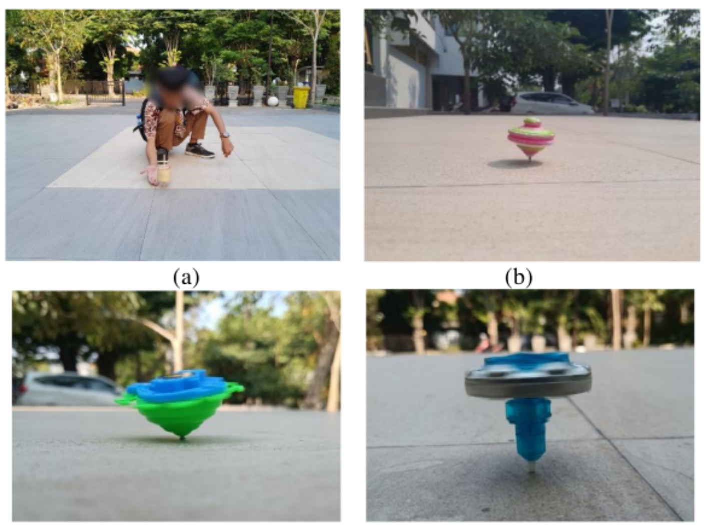

Figure 3. Observation of: (a) Bamboo *Kekehan*, (b) Wooden *Kekehan*, (c) Plastic *Kekehan*, and (d) Iron *Kekehan*

The relationship between rotation speed and radius can be determined using the second Ek_{rot} equation if it is assumed that the energy is the same.

$$\begin{aligned} Ek_{rot} &= Ek_{rot} \\ \frac{1}{2} I_A.{\omega_A}^2 &= \frac{1}{2} I_B.{\omega_B}^2 \\ {r_A}^2{\omega_A}^2 &= {r_B}^2{\omega_B}^2 \\ \frac{r_A}{r_B} &= \frac{\omega_B}{\omega_A} \end{aligned} \tag{9}$$

Based on Equation 9, the radius is inversely proportional to the angular speed, so that a *kekehan* that has a larger radius will move more slowly. Instead, *kekehan* that have small fingers have a large angular velocity and will move faster.

Figure 4. Angular Velocity Observation Using a Tachometer

Table 1. Observation Data Traditional Games of *Kekehan*

Types of kekehan	$(m \pm 0.05)g$	$(r \pm 0.05)cm$	$(\omega \pm 0.005)rpm$	$(t \pm 0.05)s$
Bamboo	85.03	4.5	3742.0	30.30
	74.24	5.5	1597.8	52.51
Wood	85.96	2.0	3366.6	21.61
	40.62	6.0	1416.4	41.79
Plastic	5.9	2.5	1175.0	15.98
Iron	43.7	2.2	7158.0	78.58

The moment of inertia (I) a quantity that states the tendency of an object to maintain its state (inertia). In rotational motion, (Figure 4), the moment of inertia can also express a measure of an object's ability to maintain its rotational angular speed. Objects that are difficult to rotate or objects that are difficult to stop while rotating have a large moment of inertia, and vice versa (see data in Table 1). The moment of inertia is defined as the product of the mass of the particle and the square of the distance of the particle from the axis of rotation. Mathematically, the moment of inertia can be formulated in Equation 10.

$$I = m\,r^2 \tag{10}$$

Also, it can be seen that the kinetic energy is directly proportional to the square of the radius of the *kekehan*, it is known that the *kekehan* is in a stationary state with an angular velocity then, the Rotational Kinetic energy of the *kekehan* is proportional to the square of the radius of the *kekehan*, this is in accordance with the following equation:

$$Ek_{rot} = \frac{1}{4}mr^2\left(\frac{v}{r}\right)^2 \tag{11}$$

So the rotational kinetic energy is directly proportional or proportional to the square of the *kekehan* radius. When the square radius is large, the rotational kinetic energy produced is large. Also, when the square of the radius is small, the rotational kinetic energy is small.

Figure 5. *Kekehan* were Thrown

When throwing a kekehan, It need initial speed so that the *kekehan* can move and spin (see Figure 5). The friction force affects the position of the *kekehan* when thrown, the friction between the rope and *kekehan* would cause *kekehan* to move. The *kekehan's* rotation can stop due to several factors, The friction force between the *kekehan*'s body and the air and the friction force between the *kekehan*'s base and the floor are the one of the reason *kekehan* stop. Due to the friction force, the rotational energy of the *kekehan* will decrease over time until the *kekehan* stops rotating. This results in the angular momentum of the *kekehan* also decreasing so that the *kekehan* is no longer upright (falling). The *kekehan* when rotating on the ground applies the principle of Uniform Circular Motion. Circular motion is the movement of an object that forms a trajectory in the form of a circle with an axis or fixed point in the center. A movement can rotate, because there is a force that can deflect it towards the center or axis of the circular path, this force is called centripetal force (*Fs*). The circular motion that occurs is the nonuniform circular motion, because the rotation of the *kekehan* gradually becomes quieter or stops. Changes in energy in the concept of the *kekehan* game can be seen when the *kekehan* starts to spin and eventually stops. This is a change in kinetic energy. When spinning on the ground, the *kekehan* which initially rotates will eventually stop because of the frictional force between the *kekehan* and the ground. When the moaning stops/is silent, there is a gravitational force to keep it rotating on its axis (Febriyanti, 2023).

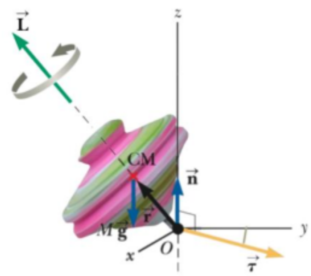

Figure 6. *Kekehan* Movement

Figure 6 is a rotating *kekehan* (spinning) on its axis of symmetry, the fulcrum of the *kekehan* is located at point O. Apart from the spin movement, the *kekehan* also performs precision movements, namely moving the axis of symmetry around the vertical axis (in this case the z axis). The force acting on the clamp is the weight force m g and the upward force at support O therefore as shown in Figure 6 the moment of force about point O is:

$$\vec{\tau} = \vec{r} \times \vec{F} = \vec{r} \times mg \quad (12)$$

The direction of the moment of this force is perpendicular to mg and r. As a result of this moment of force, the *kekehan* will move in precession. So there is the momentum dL change in time, that is:

$$\frac{d\vec{L}}{dt} = \vec{\tau} \quad (13)$$

After the interval dt, the angular momentum of the *kekehan* is the resultan of L and dL. In this case, dL is small and its direction is perpendicular to L, therefore large L otates in the horizontal plane to form a circular path with an angular velocity ω_p (berarah ke atas) of:

$$\omega_p = \frac{\frac{\tau dt}{L\sin(\theta)}}{dt} = \frac{\tau}{L\sin(\theta)} \quad (14)$$

(Serway & Jewett, 2014)

Based on Equation 14, the magnitude of the moment of force can be expressed as $\tau = \omega_p L sin(\theta)$ and written vectorly in the form

□=ω□×□ (15)

Therefore $\tau = mg\sin\ (180° - \theta) = mgr\ \sin(\theta)$, nd if substituted with the equation $\vec{L_\iota} = m_i[\vec{\omega}(\vec{r_\iota}\,.\vec{r_\iota}) - \vec{r_\iota}(\vec{r_\iota}\,.\vec{\omega})]$, then the angular velocity is known to be:

$$w_p = \frac{mgr}{L} \quad (16)$$

It can be seen that the longer the rope (radius of rotation), the slower the object's rotational speed. This argument is based on the Law of Conservation of Angular Momentum, namely

$$I \,.\omega_1 = I \,.\omega_2 \quad (17)$$

Because the moment of inertia is directly proportional to the square of the object's radius of rotation

$$I \approx mr^2 \quad (18)$$

The angular or rotational speed of an object decreases as the radius of its rotation increases. Therefore, it can be inferred that the square of the radius of rotation of an object engaged in circular motion exhibits an inverse relationship with the rotational velocity of said object. The rotational speed of an object decreases as the radius of rotation, or length of the rope, increases. However, recent observations conducted with consistent rope lengths have revealed variations in the finger movements associated with each type of *kekehan*.

It can also be seen that the density of the chortle affects the rotational speed of the *kekehan*. From the observations that have been made, it can be seen that the type of iron has a very long rotation time compared to bamboo, wood and plastic. The longest rotating *kekehan* (Figure 7) is determined by the largest moment of inertia. Because the moment of inertia is proportional to mass and radius. The mass of an object is proportional to its density. If the radius are made the same and the mass is proportional to the type of mass, then the *kekehan* that spins the longest is the one made of bamboo (the largest density). If the radius and mass are made the same, there are four types of *kekehan*, namely iron, bamboo, wood and plastic. So iron has the greatest density and will spin the longest $\rho_{Iron} > \rho_{bamboo} > \rho_{wood} > \rho_{plastic}$.

Figure 7. The *kekehan* rotates on an axis

When the *kekehan* rotates, there is a physical concept of angular momentum. An angular momentum is a particle that rotates about an axis and occurs because the object moves in rotation. The law of conservation of angular momentum is an analogy of the law of conservation of linear momentum. If we look again at Newton's second law for translational motion, a relationship similar to the law of conservation of momentum will apply. The law of conservation of angular momentum is a law that states that the amount of momentum before and after producing a collision is the same or constant. The law of conservation of angular momentum states that angular momentum is a quantity that has eternal properties.

When a rigid object (*kekehan*) rotates about an axle, the angular momentum L is in the same direction as the angular velocity ω. Each particle of the object rotates in the xy area about the z axis with an angular velocity ω. The magnitude of the angular momentum of a particle of mass m_i about the z axis is $m_i v_i r_i$ because $v_i = r_i\omega$ the magnitude of the angular momentum of this particle is expressed as

$$L_i = m_i {r_i}^2 \omega \quad (19)$$

The vector Li for this particle is directed along the z, identical to the vector ω.

$$L_z = \sum_i L_i = \sum_i m_i r_i^2 \omega = \left(\sum_i m_i r_i^2\right)\omega$$
$$L_z = I\,\omega \qquad (20)$$

The total linear momentum of a system of particles remains constant if the system is isolated, that is, if the total external force acting on the system is zero. The conservation law in rotational motion states that the total angular momentum of the system is constant, both in magnitude and direction. If the total external torque acting on the system is zero, that is, the system is isolated (Serway & Jewet, 2014). The principle of conservation of angular momentum is written as follows

$$\sum \overrightarrow{\tau_{ext}} = \frac{d\overrightarrow{L_{tot}}}{dt} = 0$$
$$\Delta\overrightarrow{L_{tot}} = 0$$
$$\overrightarrow{L_{tot}} = konstan$$
$$\overrightarrow{L_i} = \overrightarrow{L_f} \qquad (21)$$

There are many physics concepts found in the traditional *kekehan* game. So that the traditional *kekehan* game can be used as learning material based on local wisdom. In accordance with research conducted by Safitri et. al. (2018) in his research on the development of science modules based on local coffee knowledge on business and energy material said that learning modules based on local wisdom can increase student enthusiasm in learning, this has an impact on increasing critical thinking skills and student learning activities. Physics student books based on local wisdom are suitable for use and easy for students to understand. Research on the implementation of local wisdom-based materials has proven that it can increase students' skills and critical thinking results from moderate to high levels (Hunaepi et. al., 2020; Hartini et. al., 2017; Matsun et. al., 2020). Learning physics by connecting play activities or scientific events can make students understand physics concepts well because students are directly involved. Students are more interested in learning physics by playing (Maison et al, 2021)

CONCLUSION

Based on the research results, it can be concluded that the traditional *kekehan* game has a physics concept that can be studied, namely rotational dynamics. A traditional *kekehan* game that is played using various types and also different fingers. Based on the research variables, the results obtained were that there were three influencing variables, namely mass, type and radius. The first experiment showed that mass affects the angle of rotation of the keel, where mass is inversely proportional to the angle of acceleration. The second experiment showed that the radius affected the rotation time. It can also be seen that the square of the radius is proportional to the rotational kinetic energy. The radius is inversely proportional to the angular speed, so a ketch that has a larger radius will move more slowly. On the other hand, a *kekehan* with a small radius has a greater angular velocity and will move faster. Physics concepts in *kekehan* include moment of inertia, angular moment, gravity, circular motion, torque and moment of force. Based on the research results, the exploration of the physics concept of rotational dynamics in the traditional *kekehan* game can be developed as open material to assist teachers in creating physics learning innovations. It can be seen that many traditional games have physics concepts that can be linked to physics learning.

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REFERENCES

Adrianto, R. (2006). *Fisika untuk Universitas Jilid I*. Surabaya: Universitas Negeri Surabaya.

Arikunto, S. (2005). Permainan Tradisional Kekehan (Gangsingan) sebagai Media Enkulturasi dan Sosialisasi. *Makalah Workshop dan Festival Permainan Tradisional Kekehan*. Yogyakarta: BPSNT.

Astuti, I.A.D. & Bhakti, Y.B. (2021). Analisis Konsep Fisika pada Permainan Tradisional Kekehan sebagai Bahan Ajar Fisika. *Navigation Physics: Journal of Physics Education*, **3**(2), 74-79. DOI: https://doi.org/10.30998/npjpe.v3i2.869.

Astuti, I.A.D., Sumarni, R.A., Setiadi, I., & Zahra, R.A. (2022). Kajian Etnofisika pada Tari Soya-soya sebagai Sumber Ajar Fisika. *ORBITA: Jurnal Kajian, Inovasi dan Aplikasi Pendidikan Fisika*, **8**(2), 333-338. DOI: https://doi.org/10.31764/orbita.v8i2.10415.

Febrianti, K.V., Bakri, F., & Nasbey, H. (2017). Pengembangan Modul Digital Fisika Berbasis Discovery Learning pada Pokok Bahasan Kinematika Gerak Lurus. *WaPFi (Wahana Pendidikan Fisika),* **2**(2), 18-26. DOI: https://doi.org/10.17509/wapfi.v2i2.8273.

Febrianty, W., Saputra, R.D., Amri H.A., Rahmat, F.N., Handayani, R.D., & Putra, P.D.A. (2023). Eksplorasi Konsep Fisika Kesetimbangan Benda Tegar pada Permainan Tradisional Engklek sebagai Bahan Pembelajaran Fisika. *Jurnal Pendidikan Fisika*, **7**(1), 109-120. Retrieved from: https://e-journal.uniflor.ac.id/index.php/optika/article/view/2761.

Firdiani, F., Huriawati, J., & Kurniadi, E. (2019). Potensi Kesenian Tradisional Dongkrek dalam Pembelajaran Fisika pada Materi Gelombang Bunyi. *Prosiding Seminar Nasional Pendidikan Fisika*, **2019**, 1-12. Retrieved from: http://prosiding.unipma.ac.id/index.php/SNPF/article/view/1397.

Hartini, S., Misbah, M., & Resy, R. (2017). Pengembangan Modul Fisika Berintegrasi Kearifan Lokal Hulu Sungai Selatan. *Jurnal Inovasi dan Pembelajaran Fisika*, **4**(2), 157-162. Retrieved from: https://ejournal.unsri.ac.id/index.php/jipf/article/view/5411.

Hunaepi, Firdaus, L., Samsuri, T., Susantini, E., & Raharjo. (2020). Implementsi Worksheet Inkuiri Terintegrasi Kearifan Lokal untuk Meningkatkan Keterampilan Berpikir Kritis Mahasiswa. *Bioscientist Jurnal Ilmiah Biologi*, **8**(1), 158-169. DOI: http://dx.doi.org/10.33394/bjib.v8i1.2697.

Kun, P.Z. (2013). Pembelajaran Sains Berbasis Kearifan Lokal. *PROSIDING: Seminar Nasional Fisika dan Pendidikan Fisika,* **4**(1), 1-14. Retrieved from: https://jurnal.fkip.uns.ac.id/index.php/prosfis1/article/view/3316.

Larasati, T.A. (2011). *Kekehan: Permainan Kekehan Daerah Lamongan*. Jakarta: Direktorat Jenderal Kebudayaan.

Lestari, S.A., Admoko, S., & Suprapto, N. (2022). Identifikasi Konsep Fisika pada Kearifan Lokal Kayangan Api di Kabupaten Bojonegoro. *Jurnal Pendidikan Fisika*, **10**(1), 103–113. Retrieved from: https://ojs.fkip.ummetro.ac.id/index.php/fisika/article/view/4707

Maison, et al. (2021). Correlation Between Science Process Skills and Critical Thinking Skills in Jambi City Junior High School. *Jurnal Penelitian Fisika dan Aplikasinya (JPFA)*, **11**(1), 29-38. DOI: https://doi.org/10.26740/jpfa.v11n1.p29-38.

Matsun, M., Sari, I.N., & Boisandi, B. (2020). Pengembangan Buku Ajar Fisika Berbasis Karakter dengan Pendekatan Kearifan Lokal Kalimantan Barat. *Jurnal Inovasi dan Pembelajaran Fisika*, **7**(2), 162-172. DOI: https://doi.org/10.36706/jipf.v7i2.12473.

Mulyasa. E. (2015). *Pengembangan dan Implementasi Kurikulum 2013*. Bandung: Remaja Rosdakarya.

Njatrijani, R. (2018). Kearifan Lokal dalam Perspektif Budaya Kota Semarang. *Gema Keadilan*, **5**(1), 16-31. DOI: https://doi.org/10.14710/gk.2018.3580.

Nugraha, A.R. & Deta, U.A. (2023). Profil Pemanfaatan Kearifan Lokal dalam Program Unggulan Berbasis Kearifan Lokal di Sekolah: Studi Observasional. *Jurnal Ilmu Pendidikan dan Pembelajaran*, **1**(2), 51-55. DOI: https://doi.org/10.58706/jipp.v1n2.51-55.

Nugraha, B.S. & Prabowo, P. (2022). Respon Siswa SMA terhadap Pembelajaran Fisika Berbasis Kearifan Lokal pada Alat Musik Tradisional Rebana untuk Meningkatkan Keterampilan Literasi Sains. *PENDIPA Journal of Science Education*, **6**(2), 556–564. DOI: https://doi.org/10.33369/pendipa.6.2.556-564.

Nurmasyitah, Virnalita, & Lubis, N.A. (2022). Kajian Etnofisika Konsep Gerak Parabola pada Permainan Tradisional Aceh Geulengkue Teu Peu Poe. *JPF (Jurnal Pendidikan Fisika) FKIP UM Metro*, **10**(2),245-258. DOI: http://dx.doi.org/10.24127/jpf.v10i2.5217.

Putra A.M.S., et al. (2022). Analysis of Equilibrium Concepts at Traditional Dance of Tari Banjarkemuning, Sidoarjo as an Innovation of Physics Learning by Ethnoscience Approach. *Jurnal Penelitian Fisika dan Aplikasinya (JPFA),* **12**(1), 62-75. DOI: https://doi.org/10.26740/jpfa.v12n1.p62-75.

Putri, L.I. (2017). Eksplorasi Etnomatematika Kesenian Rebana sebagai Sumber Belajar Matematika pada Jenjang MI. *Jurnal Ilmiah Pendidikan Dasar*, **4**(1), 21-31. Retrieved from: https://jurnal.unissula.ac.id/index.php/pendas/article/view/1018.

Rumiati, R., Handayani, R.D., & Mahardika, I.K. (2021). Analisis Konsep Fisika Energi Mekanik pada Permainan Tradisional Egrang sebagai Bahan Pembelajaran Fisika. *Jurnal Pendidikan Fisika*, **9**(2), 131-146. DOI: https://doi.org/10.24127/jpf.v9i2.3570.

Safitri, A.N., Subiki, & Wahyuni, S. (2018). Pengembangan Modul IPA Berbasis Kearifan Lokal Kopi pada Pokok Bahasan Usaha dan Energi di SMP. *Jurnal Pendidikan Fisika*, **7**(1), 22-29. DOI: http://dx.doi.org/10.26737/jipf.v5i2.1476S

Saprima, T, Etriadi, & Nasrullah. (2020). Permainan Kekehan di Sambas. *Jurnal SAMBAS: (Studi Agama, Masyarakat, Budaya, Adat, Sejarah) Journal of Religious, Community, Culture, Costume, History Studies*, **3**(1), 13-27. DOI: https://doi.org/10.37567/sambas.v3i1.194.

Sari, F.P., Nikmah, S., Kuswanto, H., & Wardani, R. (2019). Developing Physics Comic Media A Local Wisdom: Sulamanda (Engklek) Traditional Game Chapter of Impulse and Momentum. *Journal of Physics: Conference Series*, **1397**, 012013. DOI: https://doi.org/10.1088/1742-6596/1397/1/012013.

Satriawan, M. & Rosmiati. (2016). Pengembangan Bahan Ajar Fisika Berbasis Kontekstual dengan Mengintegrasikan Kearifan Lokal untuk Meningkatkan Pemahaman Konsep Fisika pada Mahasiswa. *Jurnal Penelitian Pendidikan Sains*, **6**(1), 1212-1217. DOI: https://doi.org/10.26740/jpps.v6n1.p1212-1217.

Serway, R.A. & Jewett, J.W. (2014). *Physics for Scientists Engineers Modern Physics* 9th Ed. Boston: Brook/Cole.

Suprapto, N., Prahani, B.K., & Deta, U.A. (2021). Research Trend on Ethnoscience Through Bibliometric Analysis (2011-2020) and the Contribution of Indonesia. *Library Philosophy and Practice (e-journal)*, **2021**, 5599. Retrieved from: https://digitalcommons.unl.edu/libphilprac/5599/.

Syahda, E. & Deta, U.A. (2023). Needs Analysis of Physics Learning Media Integrated Local Wisdom. *International Journal of Research and Community Empowerment*, **1**(1), 39-45. DOI: https://doi.org/10.58706/ijorce.v1n2.p39-45.

Wulansari, N.I. & Admoko, S. (2021). Eksplorasi Konsep Fisika pada Tari Dhadak Merak Reog Ponorogo. *PENDIPA Journal of Science Education*, **5**(2), 163-172. DOI: https://doi.org/10.33369/pendipa.5.2.163-172.

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