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Analysis of Physics Concepts in Gasing Games

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ABSTRACT

The gasing game is a game where the gasing can rotate on an axis and balance at one point. This game is classified as one of the traditional games in Indonesia which is starting to disappear. One way to preserve this game is to integrate it with learning at school. Therefore, the authors are interested in studying the physics concepts contained in tops so that they can be used during physics learning activities in class. The method used in this study is a qualitative method, which is a procedure that produces descriptive data in the form of written or spoken words from people or observable behavior. Based on the research that has been done, it can be concluded that there are many physics concepts in top games, including the balance of rigid bodies, frictional forces, work, moments of inertia, and rotational motion, as well as kinetic energy as well as gravitational forces. So that traditional gasing games can be integrated with physics learning at school with the hope that students will learn physics more easily so that students have the desire to always study physics and be able to understand physics material properly and optimally.

INTRODUCTION

Physics is a very important science in life (Saregar, 2016). In physics, we learn about the universe and everything in it, from the motion of objects to gravity, which is studied in physics. Physics lessons related to natural phenomena are obtained through exposition known as scientific composition and interaction with nature (Puspitasai & Mufit., 2021). Without ever realizing that physics is very close to us, many of our daily activities have or even apply physics concepts. One of them in a game. Game according to Bettelheim is an activity characterized by the existence of rules that are mutually agreed upon and determined from the outside to carry out an activity that has a purpose (Azizah, 2016). From the opinions that have been stated previously, it can be seen that the game is an activity that has the goal of measuring a child's ability and potential (Widya et al, 2020). Games can be divided into two types, namely traditional games and modern games (Brigita, 2020).

Traditional games are one of the cultures that exist in people in certain areas that have existed since ancient times and have been played for generations. Apart from the type, traditional games are also differentiated based on the tools, so there are traditional games that use tools and there are traditional games without using tools. In addition, there are games that are competed and there are also games that are not competed (Azizah, 2016). In traditional games there are several games that are closely related to the concept of learning physics, one of which is the top game (Azizah, 2016).

According to Putra (2016) gasing or gangsing is a game that can rotate on an axis and balance at one point. Currently, there are two types of gasing games, namely traditional

tops and modern tops. The traditional gasing is made of wood or bamboo which is carved and shaped to resemble a tube, cone and so on, the tool used to move the gasing is a rope or thread. In addition to the traditional "tops" nowadays, there are also modern gasing made of plastic with shafts made of iron (Brigita, 2020). The game gasing relates to material in physics learning such as the relationship to the concept of rigid body equilibrium and the concept of pressure (Azizah, 2016). Based on Sintauri's research in (2020) there are several factors that cause sound in a gasing namely the size of the gasing, frictional force, and the wind that enters the gasing when the gasing rotates. So, the mathematical aspect lies in the size and shape of the gasing while the physical aspect lies in the stability of the gasing, the mass of the gasing, resistance and frictional force on the top.

The urgency of this research is that gasing can be seen from cultural, social, and educational perspectives in the context of physics. According to Sudarin in (Astuti, 2021) the physics learning process in schools at this time only focuses on the main materials contained in books and does not use the problems that exist around students as teaching media for physics learning. The concept of physics contained in the gasing game is expected to make it easier for teachers to convey learning material to students. So that with research that examines the concept of physics in gasing, it is hoped that it can help teachers find alternative physics learning media that are close to students.

RESEARCH METHOD

The method used in this study is a qualitative method, which is a procedure that produces descriptive data in the form of written or spoken words from people or observable behavior (Meloeng, 2011). In a qualitative study, the emphasis is on social situations by suppressing in an effort to answer questions from researchers by thinking formally and argumentatively (Kasyanto, 2019).The object of research is traditional tops sold in toy stores.The source of data in this study comes from selected information (Proposife Sampling) according to the function it has.The instruments used in this research is the researcher himself (Human Instrument), in its implementation the researcher is also accompanied by various tools in the form of sound and image recorders, and video recorders (Kasyanto, 2019).The research begins with collecting qualitative data through observation, documentation study, literature study related to gas games.

1) The data collection stage, where at this stage the collection of articles from several journals related to the concept of physics and observations related to the gasing game directly along with documentation studies and literature studies related to the gasing game; 2) Data reduction or categorization, namely the selection or categorization of data according to needs; 3) Appearance of data, where researchers can determine the type and form of data presented in the form of narrative text; 4) Drawing conclusions, the conclusions obtained must include all important information related to the research.

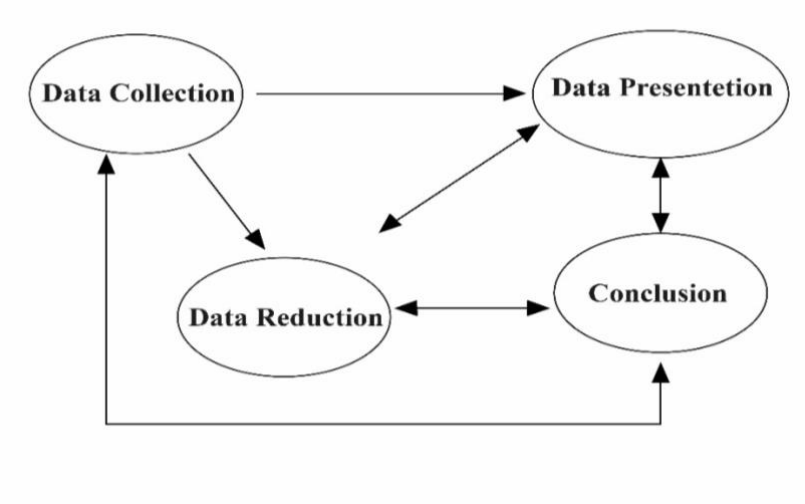

Figure 1. Flow of Qualitative Methods

RESULTS AND DISCUSSION

The gasing game that we often encounter and even play is inseparable from the concept of physics. The game of gasing is included in the local wisdom of the Jakarta area. Local wisdom is a culture or tradition that has been passed down from generation to generation and is characteristic of a particular area. This gasing game can be linked to physics learning, which can be seen from the process of playing it and almost all games have elements of physics. Based on the research of Sintauri, Puspitasari, & Noviyanti (2020) which stated that in the gasing game there are physics concepts that can be assessed, namely stability, frictional force, resistance, and object mass.

Figure 2. Traditional Gasing
Source : Author Documentation

Results of Observation of Physics Concepts

Based on the results of the literature study and observations made. The concepts of physics in traditional and modern top games are obtained as shown in table 1.

Table 1. results of observations of physics concepts on traditional tops and modern tops

Physics Concept	Gasing Game	Explanation
Rigorous Equilibrium	Shape of gasing	Gasing are designed in a tube- or cone-like shape with a sturdy material that is not easily damaged. This shape was chosen so that the gasing can balance and rotate for a long time, this is in accordance with the concept of physics, namely the equilibrium of rigid bodies.
Friction	When throw the gasing	Frictional force is influential when throwing gasing to spin. The friction that occurs between the rope and the gasing causes the gasing to spin which is initially stationary and then rotates on its axis.Frictional force also affects the rotation of the gasing on the ground, the greater the frictional force, the faster the gasing stops rotating
Work	When throw the gasing	The work occurs when the player throws a gasing from the handrails into the arena or onto the ground. gasing are thrown with a force (F) then move as far as (s) then a work of (J) will appear
Moment of Inertia	When the gasing spining	When the gasing rotates on the ground or on the ground, there is a valid physics concept, namely the moment of inertia, where the top maintains its position so that it continues to rotate.
Rotation Motion	When the gasing spining	When the gasing rotates on the ground or on the ground, there is a physics concept that applies to rotational motion because when the gasing rotates, the gasing rotates at a fixed point or can be called rotating on an axis..
Kinetic Energy	When the gasing spining	When the gasing starts rotating and then stops, a change in energy occurs there, namely a change in kinetic energy where the gasing rotates at a certain speed and then stops and the speed becomes 0.
Gravity	When the gasing spining	The force of gravity affects the gasing to keep rotating on its axis

Shape of Gasing

The shape of the gasing, which is designed to resemble a tube or cone, aims to balance the top and last longer when rotating. The rigid body equilibrium here is a situation where the gasing has zero momentum. Where when the gasing is silent, then the gasing remains silent. However, if a gasing moves at a constant speed, then it will still move at a constant speed (Astuti, 2021). When the gasing moves and rotates on its axis, the resultant force from the gasing causes 2 movements, namely translational motion and rotational motion (rotating on a certain axis). Translational motion is caused by a force that causes the gasing to move, while rotational motion is caused by the torque (force moment) acting on the gasing.

Figure 3. Spinning gasing balance
Source: Author Documentation

When Throw the Gasing

Gasing can move or rotate, when the rope wrapped around the gasing is pulled with a certain force. When a player throws a gasing and the rope wrapped around the gasing is pulled, there will be a frictional force between the rope and the gasing, which causes the gasing to rotate. If the driving force continues to increase, the static frictional force will also increase, but the gasing remains stationary. If the driving force in this case is the gasing rope is still smaller than the maximum limit of static friction then the gasing will remain stationary. As soon as the driving force exceeds the maximum static friction force limit, the object starts to move (Mikrajuddin, 2016). When throwing a gasing, it is known that the driving force, namely the rope being pulled, is greater than the maximum frictional force limit so that the top, which is initially stationary, then rotates or moves on its axis.

Figure 4. Illustration of changes in friction as a function of driving force
Source: Mikrajuddin (2016)

When the gasing is rotating on the ground or a flat surface, the existing frictional force will be converted into kinetic frictional force. For slow motion (quite small speed) the kinetic friction force has only one value, independent of the relative velocity between the two contacting surfaces (Mikrajuddin, 2016). The magnitude of the kinetic friction force can be written as follows:

$$f_k = \mu_k N$$

In order for the gasing to keep rotating on the ground, in theory the force needed is smaller than the force required when pulling the gasing so it can rotate. This is what

causes when you first pull the gasing, the pull feels more loose than when the gasing has been spinning a little. This property results in the following inequalities:

$$f_k \; f_{s,maks} \; or \; \mu_k N < \mu_s N$$

When the gasing stops, it can be concluded that the frictional force on the ground is greater so that periodically the gasing speed starts to decrease until the gasing finally stops spinning. In addition to the frictional force when throwing a gasing, there is also another physics concept, namely the concept of work. When throwing a gasing to the ground, the gasing gets a force of F so that the gasing can balance and rotate. A spinning gasing will experience a slight displacement of s to remain able to rotate and maintain its equilibrium state until eventually it stops due to the frictional force experienced by the bottom surface of the gasing with the ground. Because the gasing gets the force and experiences displacement, it can be said that the gasing is doing work. The amount of work done by the gasing is formulated as follows.

$$W = F.s$$

The greater the force and displacement carried out by the gasing, the greater the work done by the gasing.

Figure 5. A spinning and balanced top
Source : Author Documentation

When the Gasing Spining

When playing a gasing, the gasing that is thrown does not immediately rotate on its axis but moves first in various directions until it finally stops at one point and then rotates on its axis until the gasing stops. When the gasing moves there is energy in it. The energy referred to in the motion of this gasing is kinetic energy, kinetic energy can be formulated as follows:

$$Ek = \frac{1}{2}mv^2$$

The greater the mass of an object (for the same speed), the greater the force needed to restrain the object's motion. From this it can be concluded that the energy of an object's motion is proportional to the object's mass to a positive number power (Mikrajuddin, 2016). From this statement it can be concluded that the mass of the gasing affects its kinetic energy. The greater the mass of a gasing, the greater the force needed to move the gasing so that the kinetic energy possessed by the gasing will be even greater.

When the gasing is played, the gasing will rotate on its axis or it can be called rotating. When the gasing rotates, there is a concept of physics, namely rotational motion in it. Rotational dynamics is basically the same as Newton's second law for translational motion, namely $\vec{F} = m\vec{a}$ A rotating gasing is strongly influenced by torque so that the equation in Newton's second law changes to:

$$\vec{\tau} = I\vec{a}$$

With I the moment of innesia of the object and a ⃗ is the angular acceleration of rotation.

Figure 6. Direction of gasing rotation
Source : Author Documentation

Because the gasing is played on the ground, the gasing is influenced by the central force, namely the force of gravity. The moment of force produced by the central force always points to the center (Mikrajuddin, 2016). The resulting central moment of force can be written.

$$\vec{\tau} = \vec{r}\, x\, \vec{\tau}$$
$$= r\hat{r}\, x(-F(r)\hat{r})$$
$$= rF(r)(\hat{r}\, x\, \hat{r}) = 0$$

Gasing has a shape like a tube with a certain height, volume and radius. Gasing is considered functioning or can be played when the gasing can rotate on its axis. When the gasing rotates and moves, the kinetic energy described earlier will appear. In rotational motion, the kinetic energy is formulated as follows:

$$Ek = \frac{1}{2}(mr^2)\omega^2$$

In translational motion, m is called inertia, because of the similarity of this function, rotational motion is defined as mr^2 as the moment of inertia (Mikrajuddin, 2016). So, a gasing that rotates on its axis and has a radius, the top can be said to have a moment of inertia that fulfills the equation:

$$I = mr^2$$

When determining the moment of inertia that must be considered, namely the radius of the gasing. Gasing with one another could have a different moment of inertia if the radius of the top is different.

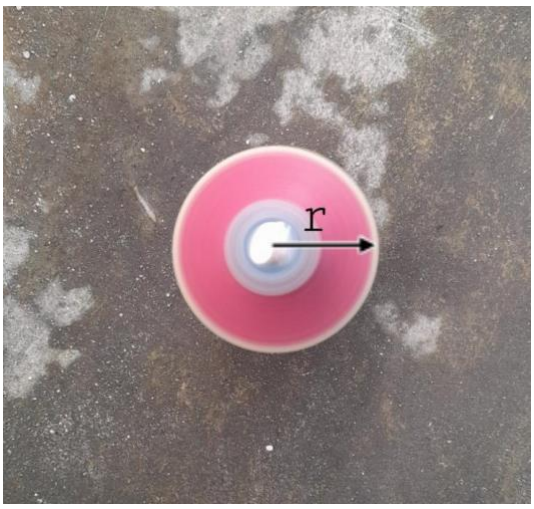

Figure 7. Gasing radius
Source: Author Documentation

The larger the radius of the gasing, the greater the moment of inertia, but the smaller the resulting angular velocity. Conversely, if the radius of the gasing is smaller, the moment of inertia will be smaller, while the angular velocity will be greater. The greater the moment of inertia of a gasing, the longer it can maintain its equilibrium. When the gasing moves, that's where there is a gravitational force that causes the gasing to spin and maintain its balance. This gravitational force is the gravitational force of the gasing on the earth (soil) and vice versa, namely the gravitational force of the earth on the gasing. The magnitude of the gravitational force from the gasing to the earth can be formulated as follows.

$$F = G\frac{m_1 m_2}{r^2}$$

The magnitude of the gravitational force is directly proportional to the multiplication of the mass of the gasing and the mass of the earth and inversely proportional to the square of the distance from the gasing and the earth. Where when the force multiplication of the mass of the gasing and the earth is getting bigger and the square of the distance between the gasing and the earth is getting smaller, the gravitational force experienced by the gasing is getting bigger. Conversely, if the square of the distance between the gasing and the earth is greater and the multiplication of the mass of the gasing and the earth is smaller, then the gravitational force experienced by the gasing is also smaller.

In everyday life, the traditional gasing game is an example of a simple traditional game that contains many physics concepts from the many physics concepts that can be learned in the surrounding environment. We can introduce to children that all the phenomena that occur in our daily lives are knowledge that can be learned unconsciously. This game is one of the games that we encounter and is usually played by children so that it can be applied in learning physics at school. In addition, traditional games can also be a source of learning physics on kinematics concepts. With the integration of learning physics with local wisdom in the form of traditional gasing games, it is hoped that it will be easier for students to understand physics concepts so that students want to study physics and can understand physics material properly and optimally (Astuti et al, 2021).

Based on the results of the analysis of the physics concept of the gasing game, there are several physics concepts contained in the game, namely the balance of rigid bodies, frictional forces, work, moments of inertia, and rotational motion, as well as kinetic energy and gravitational forces. All of these concepts are analyzed starting from the gasing being launched until it stops moving, so it can be said that learning physics can be done through playing activities. Physics learning related to play activities or scientific events can make students understand physics concepts well, because students play a direct role in the game so that students are more interested when learning physics by playing (Astuti et al, 2021).

CONCLUSION

Based on the results of the research in the form of direct observations and literature studies, it can be concluded that the traditional game of gasing contains various physics concepts in the game process including, the balance of rigid bodies, frictional force, work, moment of inertia, rotational motion, kinetic energy, and gravitational force. So that traditional gasing games can be integrated with physics learning at school with the hope that students will learn physics more easily so that students have the desire to always study physics and be able to understand physics material properly and optimally.

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