JSER

Journal of Science Education Research
Journal homepage: https://journal.uny.ac.id/index.php/jser/index

ISSN: 2597-9701

Exploration the Ethnoscience of Gasing Game from Malay Riau Culture and its Potential for Physics Learning

T. Elviana[1*], W. Liliawati[2], S. Sriyati [3]
[1,2,3]*Science Education, Faculty of Mathematics and Science Education, Universitas Pendidikan Indonesia*
[*]*Corresponding Author. Email: tika.elviana@upi.edu*

Keywords
Ethnoscience, *Gasing Games*, Physics, Learning, Malay Culture

Phone*: +6282383320330

Abstract

Gasing is a traditional game played by the Malay people of Riau, crafted from wood shaped like an inflated fruit, with a rope made from bark. This game is played by the Malay community in Riau to spend time with friends and to celebrate special occasions in the province. The research explored the methods of making and playing *gasing* by the Malay people of Riau and analyzed the physics concepts involved in the game. This qualitative study employed a literature review, observation, and interviews. The literature review examines Malay culture and *gasing* games. Observations were conducted in Siak Regency to directly observe the *gasing* games, including the tools and materials used, the game rules, and player interactions. Interviews with cultural experts provided insights into the cultural significance and traditional knowledge of the Malay community about the game. The findings reveal that *gasing* is made using merbau wood (*Intsia bijuga*) and bebaru bark (*Thespesia populnea*). In play *gasing*, the rope is wound around the body of the *gasing*, and the player takes a stance holding the *gasing*. The *Gasing* is then thrown to the ground with a sharp jerk of the rope, causing it to spin rapidly and for a long duration. Observations identified several physics concepts in the game, including balance, mass distribution, friction force, moment of inertia, rotational motion, angular momentum, kinetic energy, and surface area. The application of physics concepts in *gasing* highlights its potential as a valuable resource for ethnoscience-based physics learning.

History
Received: November 24, 2023

Revised: January 13, 2024

Accepted: February 21, 2024

How to cite:
T. Elviana., W. Liliawati., S. Sriyati. (2024). Exploration the Ethnoscience of Gasing Game from Malay Riau Culture and its Potential for Physics Learning. *Journal of Science Education Research*, 8(2), 120-132. doi:https://doi.org/10.21831/jser.v8.i2.75081.

INTRODUCTION

Indonesia has many different cultures. According to the The Great Dictionary of the Indonesian Language (abbreviated as KBBI), culture means the results of human activities and inner creation (intellect), such as beliefs, arts, and customs. Every country must have its culture. In Indonesia, culture is divided into two sub-heritages, namely tangible and intangible cultural heritage. Tangible cultural heritage includes 2319 cultural heritage and 435 museums, while intangible cultural heritage consists of arts, history, beliefs, and traditions (Kemendikbud, 2019). Indonesia has 735 regional languages, 1351 art instruments, 1087 types of traditional food, and 261 traditional fabrics. Culture in Indonesia is not only limited to those mentioned but also includes traditional games spread across various regions in Indonesia. Traditional games in Indonesia are about 766 traditional games (Kemendikbud, 2019).

Folk games are part of the oral tradition, in essence, games are the same as traditional. Folk games are traditionally played games owned by a commune and are passed down from generation to generation orally (Fibiona, 2021). Folk games are played with simple methods, for example, based on body movements such as running and jumping, or

based on simple social activities such as chasing, hiding, and fighting; or basic mathematics or hand dexterity such as counting and throwing stones into a certain hole. Everything is expressed through physicalmovement, singing, dialogue, singing and dialogue, guessing, accuracy in counting and answering questions, learning communication, and so on (Sanjayanti, 2022).

Folk games are generally played by children, but certain games are also played by adult men (Siahaan, 2019). It is played between 2 to 15 players aged 4 to 16 years. Some games distinguish between boys and girls, but in certain games such as *galah panjang, patok lele, kasti, Malay chess*, and *ya oma ya oma* games, boys and girls are not distinguished (Sufa et al., 2021; Ningtiasih et al., 2020). Folk games that rely on physical strength are generally played by boys - for example, thegame of gasing or sepak raga, which is the application of a custom and socio-cultural value that isconsidered taboo for girls to play (Cendana et al., 2022; Sutini, 2018). In certain types, folk gamescan be classified as sacred games that use magical powers (Permadi et al., 2021; Kristanto, 2020).

Games are usually played to fill leisure time, which can be seen based on daily, weekly, and seasonal (Fikraturrosyida, 2018). Daily games are carried out almost every day and are usually light games that do not require special equipment. Weekly are carried out on weekdays (markets), because many peers gather today. While seasonal is carried out following certain seasons, for example, the *menugal* season (planting rice), reaping, rainy season, and others (Dewi et al, 2020).

The history of traditional games comes from the culture of the local community, not from foreigners as some people often think. Nowadays, games are only about losing or winning. However, in the past, traditional games were used as offerings, devotion to the country, or a way of doing a job. With the development of the times, people began to forget traditional games and switched to modern games (Sintauri, 2020). *Gasing* is one of the traditional games in Indonesia. Apart from being a toy for children and adults, gasing is also used for matches. This spinning *Gasing*toy is widely sold in the city of Yogyakarta. According to (Putra et al, 2016), a *Gasing* or gangsing isa toy that can rotate on an axis and balance at a point.

Based on the nature of the game, folk games can be divided into two broad groups, namely games to play (play) and games to compete (game) (Algiffari, 2015, Winarsih, 2017). The difference between the two is that the first is more like filling leisure time or recreation while the second is carried out by the method of competition. The *Gasing* game is found in almost all Malay countries, including the Riau and Riau Islands. Although it is a fairly old game, it still exists today. There are often competitions or festivals of *Gasing Games*, both in Indonesia and Malaysia.

Gasing as a folk game is divided into two groups: games for playing and games for competing (Algiffari, 2015; Winarsih, 2017). Games for playing are more recreational, while games for competing are played using the competition method and purpose. *Gasing*, a Malay folk game made of wood, is still popular in the Riau and Riau Islands, and Malaysia. The shape of a *Gasing* varies from region to region but generally consists of a head, body, and a shaft pointed at the bottom. The type of wood used to make the *Gasing* varies, such as merbau (*Intsia bijuga*), *kempas* (*Koordersiodendron pinnatum*), and *kemuning* (*Murraya paniculata*). The string is usually adjusted to the length of the player's hand and is often rubbed with coconut oil for a good spin.

Gasing competitions include gasing uri, gasing pangkah, and gasing paduk competitions. Gasing uri is judged on its durability and spin stability while gasing pangkah focuses on pangkah fighting. In playing gasing, a rope is wrapped under the header to cover half or almost the entire body of the gasing. Then, the *Gasing* is thrown to the ground by pulling the rope as hard as possible so that the *Gasing* spins quickly. A great *Gasing* is tight, steady, spins for a long time, and often wins in slam competitions.

Gasing is the oldest game found in archaeological sites and is still recognisable. Each region also has a different term to refer to this *Gasing*. The people of West Java and DKI Jakarta call it gangsing or panggal (Mulyaningsih et al., 2023). Lampung people call it *pukang*. East Kalimantan people call it *begasing*. In Maluku, it is called *apiong*. The Bugis people of Makassar and the people of West Nusa Tenggara call it *maggasing*. While the Bolaang Mangondow people in the North Sulawesi region gave the name *paki*. East Javanese people call the *Gasing* as *kekehan*. While in Yogyakarta, the *Gasing* is called by two different names. If it is made of bamboo, it is called*gangsingan*. I If it is made of wood, it is called *pathon*. Meanwhile, the people of Riau, Riau Islands, Jambi, Bengkulu, and West Sumatra, like Peninsular Malaysia, still call it *Gasing* (Herman et al, 2018).

In games, it is behaviour, lifestyle, and learning. Children have left traditional games that are considered old-fashioned and not fun anymore, even though there are many benefits that can be obtained from a variety of traditional games. Ethnoscience physics itself is a cultural

element contained in physics learning (Warli et al, 2022; Astuti et al, 2021). Sometimes physics is difficult for students to understand because the physics learning process tends to be formal and rigid and less fun. In addition, the understanding of values in physics learning delivered by teachers has not touched all possible aspects. There are indications of an unfamiliar relationship between physics material at school and the daily lives of local students (Gifani et al., 2023).

It makes students overthink practically how the formulas that have been taught are only implemented to answer questions (Sintauri, 2020). Primary to secondary school students who are in the concrete phase and play period need a touch of physics material that is real and often encountered and fun. So, the elements of physics that exist in *Gasing* need to be studied further to improve understanding of physics in a fun way. Rationalization of traditional games has a positive impact on student achievement by integrating local culture into science learning. Linking learning materials to local culture, such as *Gasing Game*, can improve students' scientific literacy. By using traditional games as a learning context, students can more easily understand scientific concepts and apply them in everyday life, thereby improving their academic achievement (Yuliana et al, 2023; Pangestu et al, 2020; Primaharani et al, 2024).

The study aimed to (1) Identify and describe the local knowledge of the Riau Malay community in Siak Regency regarding the *Gasing Game*, including materials, manufacture, and playing techniques; (2) analyze the physics concepts underlying the *Gasing Game*; and (3) design an ethnoscience-based learning model that integrates the *Gasing Game* to improve students' understanding of physics concepts.

In this case, the study was conducted in the form of an exploration of the physics contained in *Gasing* as a Malay Riau folk game. Based on this, the purpose of this research is to find out how the *Gasing* culture is carried out in Siak Regency, Riau Province, how the original knowledge of the community regarding the *Gasing Game*, what materials are used to make a *Gasing*,how to play a *Gasing* and what learning recommendations can be applied in ethnoscience-based learning with *Gasing Game*.

RESEARCH METHOD

The research methodology used a qualitative study based on field literature review and interviews. Another methodology used was observation by observing the process of making *Gasing* and playing the *Gasing Game*. The research procedure is illustrated in Figure 1.

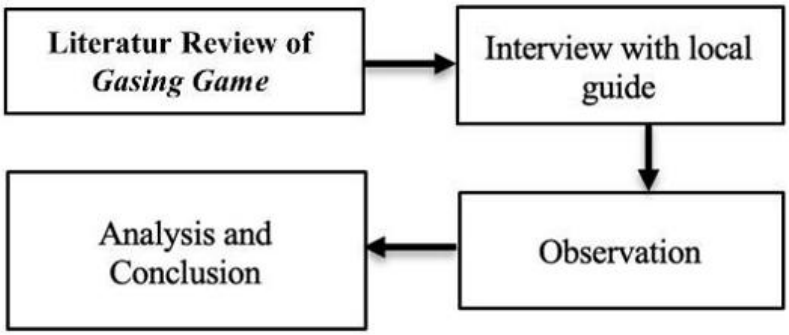

Figure 1. Research procedure (Creswell, 2019)

The first stage was a literature review by reviewing various books and journals on Malay Culture regarding the *Gasing Game* in Malay society, Riau. Furthermore, field observations were carried out in Siak Regency, Riau Province. This observation was carried out to directly observe the tools and materials used in the *Gasing Game*, how the *Gasing Game* is played, the rules of the game, and the interaction between players.

The researcher also documented the process of making the *Gasing* and the materials used and conducted interviews with the culturists of the *Gasing Game* festival.The interviews aimed to find out and obtain in-depth information related to the game and culture of gasing and aimed to explore information about the meaning and cultural valuescontained in the *Gasing Game*, as well as the original knowledge of the Malay community relatedto the *Gasing Game*. The interview was conducted with a culturist and the Head of the Tourism Marketing Division of Siak Regency, Mr. Basriansyah, because he has in-depthknowledge about the culture of the *Gasing Game* in Siak Regency, Riau Province in January 2014. The questions are presented in Table 1.

Tabel 1. List of Questions' Interview

Questions
Would you like to explain the traditional *Gasing Game* tradition in Melayu Riau? What is the value of playing the *Gasing Game* or the value of the tradition of the *Gasing Game*?
What are the instruments used in the *Gasing Game*? What kind of wood is used to make a *Gasing* and what rope is used to play a *Gasing?*
How to make the *Gasing*?
How to play the *Gasing Game*?
What is the original knowledge of the *Melayu Riau* people about the *Gasing Game*?
Can I relate the *Gasing Game* to physics education?

After the interviews, the next step was observation, including analysing the size and materials used to make the *Gasing*s and their components. Size analysis was carried out by measuringthe diameter and height of the *Gasing* and the materials used. After measuring the size of the *Gasing*, observations were made on how to use and play the *Gasing* to observe any indication of physics material involved in the process of playing the *Gasing*.

Based on data, an analysis of the Gasing Game is carried out based on observations on the relevant physics theories to the Gasing Game. The analysis started with a Physics analysis. A systematic identification of various physics concepts underlying the spinning top game was carried out. These concepts can include force, circular motion, angular momentum, kinetic energy, and others.

After identifying the physics concepts, it analyzed how these concepts are manifested in the spinning top game. For example, how the force applied to the rope affects the speed of the spinning top or how the shape of the top affects its stability.

It analyzed the relationship between the spinning top game and the values adopted by the Malay community, Riau. The final analysis was to synthesize knowledge, namely by trying to unite an understanding of physics with knowledge of culture to show that science is not always separate from culture, but the two can complement each other. Based on the analysis, it concludes the theory of physics related to the Gasing Game and its relation to the philosophy prevailing in the Malay community, Riau. After discovering the principles of science in the culture of the game, the recommendations for the utilisation of the game in physics education are outlined in the learning design.

RESULT AND DISCUSSION

Siak Regency is an area in Riau Province with very thick Malay traditions and culture. Various aspects of community life, ranging from the language used daily by the Siak people is Malay. This language has its distinctiveness and is different from Malay in other areas (Safitri et al., 2020). The Siak people still uphold Malay customs, such as wedding customs and welcoming guests, which are still preserved and practiced in everyday life (Angrayni, 2021). Especially the various cultures widely preserved in Siak Regency, including the typical Malay Riau clothing, Malay Riau dances and traditional Malay Riau games, namely the *Gasing* game. (Artis, 2018).

The origin and history of the *Gasing Game* in the Malay land of Riau, one of which is that this *Gasing Game* is the result of the discovery of the flowering fruit (*Sonneratia Aseolaris*) on the beach.Due to the round, slippery, and flat structure of the fruit, it is easy to spin fast and long. The Malay community then adopted this *Gasing Game* by using wood that was easy to shape (Amri, 2022). The discovery of *berembang* fruit by the community on the beach made this *Gasing Game* popular as a leisure time filler after working in the sea (Jasman & Siti Zaiton, 1996).

Figure 2. Seaside Emerging Fruit Trees and Emerging Fruit Forms

The Riau Malay Gasing, known as "*Gasing Berembang*," is beautiful and functional. It resembles an inflated fruit, with a wider, flattened *Gasing* and a smaller, tapered bottom. This shape is carefully designed to produce a stable and long-lasting spin. (Laini, 2023). Based on the interview with a respondent who is one of the cultural figures of Riau folk games and also a Head of Tourism Marketing, at Siak Regency Tourism Office, Riau Province, *Gasing* is an object made of wood. The bottom is pointed, while the *Gasing* is like a head, round in shape, which is called a crest. And, a little neckis a small indentation or just a wedge between the body and the crest of the *Gasing*.

Figure 3. (Left) Gasing that is shaped like a gourd, (Right) Forces that work on *Gasing*

The function of the spinning *Gasing* neck is to wrap the *Gasing* rope. While its pointed bottom, the community mentions for *Gasing* rotating on its axis at one point when played onthe ground or a flat field, floor or even on a *tapuk* board, a small piece of board used to lift *Gasing* that is fast rotating (Rahman et al, 2012). Based on Figure 3b, the explanation of the forces on the top involves several types of forces that play a role in keeping the top spinning and stable. The central force (centripetal force), shown by the circular blue arrow, directs the top to move in a circular path, keeping the top in its rotating path. The torque, shown by the purple arrow, comes from the pulling force of the string, provided by the string that is wrapped around the top's axis and pulled quickly, causing the top to spin. The friction force, shown by the green arrow on the bottom of the top, is the friction force between the top's surface and the ground that affects how long the top can spin, gradually slowing the rotation until it finally stops. The gravitational force, shown by the red arrow pointing down from the center of the top, pulls the top down, providing stability to the top as it spins. By understanding this picture and explanation, we can see how the various forces work together to make the top spin stably.

Respondents mentioned that the components of a *Gasing* are always the same, the body, the crest and the axis, and the pointed bottom. Only the appearance always varies slightly from one region to another. Some are oval round, some are shaped like a heart, cone, or cylinder, andsome are shaped like a flying saucer. *Gasing* consists of the head, body, and legs (axis) (Rahman, 2008).

Woods often used to make gasing include *merbau* (*Intsia bijuga*), *kempas* (*Koordersiodendron pinnatum*) and *kemuning* (*Murraya paniculata*), *rambai* (*Baccaurea motleyana*), bebaru (*Thespesia populnea*), *durian* (*Durio zibethinus*). But the most suitable wood is *merbau* (*Intsia bijuga*), such as *merbau tanduk, merbau darah, merbau johol* and *merbau keradah*. These types of wood are easy to pull but do not splinter or crack easily. *Gasing* can also be made from readily available woods such as manggis woods (*Garcinia mangostana L.*) and sawo wood (*Manilkara zapota L.*). Respondents mentioned that the type of wood used to make gasing is merbau wood. According to gasing-making culturists, this wood is used because of its durability and abundant availability, making it easy to obtain. Merbau wood is a wood commodity, commonly foundin Siak Regency due to its coastal environment. The taxonomy of merbau wood is presented in Table 2.

Table 2. Wood Taxonomy of *Gasing Game*

Taksonomy	Merbau Wood
Class	Magnoliopsida
Ordo	Fabales
Family	Fabaceae
Genus	Intsia
Species	*Intsia bijuga* *Intsia palembanica*

Respondents said that to get a *Gasing* that is strong and resistant to stepping, people always choose the hardest wooden terrace. The heartwood is the hardest part of the log. Meanwhile, the simplest ones are often made only from jackfruit wood. For children's *Gasing Game*. The more expertly a person makes and sews his spinning *Gasing*, the more interesting the shape and softness of the *Gasing Game* when played.

In the past, *Gasing* was made from the skin of the bebaru (*Thespesia populnea*). Now people often use easily available ropes, such as nylon rope and others. The rope used to play the *Gasing* adjusts to the length of the player's hand, but in general, it is about one meter. Likewise, the thickness of the rope adjusts to the size of the spinning *Gasing*. To get good rotation results, it is not uncommon for the *Gasing* rope to be rubbed with coconut oil. So, the spinning *Gasing* looks a bit shiny. The taxonomy of *bebaru* wood is presented in Table 3.

Table 3. *Bebaru* Wood Taxonomy of *Gasing Game*

Taksonomy	Merbau Wood
Ordo	Malvales
Family	Malvaceae
Genus	Thespesia
Species	*Thespesia populnea*

A great *Gasing Game*, spinning fast, stable, long spinning and always wins when a stepping competition is held. There are several types of *Gasing Game* competitions, namely the *Uri Gasing Game* competition, the *Pangkah Gasing Game* competition, and the *Paduk Gasing Game* competition. *Gasing Uri* is competed for gasing that is durable, spinning fast, and steadily rotating on its axis at one point. *Gasing pangkah* is competed for *pangkah* fighting. In addition to *gasing uri* and *gasing pangkah* there is also *gasing pinang*, whichis a *Gasing* used for children (Azhar et al, 2019). The way to play a spinning *Gasing* starts by wrapping the spinning *Gasing* rope under the crest to the body of the *Gasing* until it covers half or almost the entire body of the *Gasing*. The next step is to takea stance. The spinning *Gasing* is held firmly with one hand. Once ready, the *Gasing* is immediately thrown to the ground while jerking the rope as hard as possible so that the *Gasing* slides to the ground while spinning as fast as the *ligat* (Hamidy, 2014). The process of playing the *Gasing* is illustrated in Figure 4.

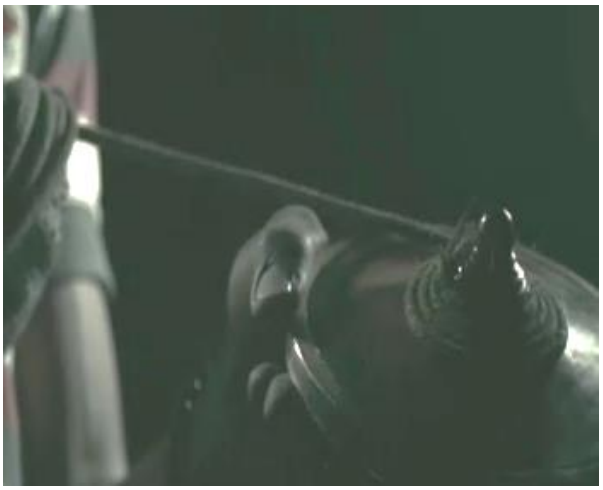

Figure 4. The rope is wrapped around the *Gasing*

In the culture of the Malay people of Riau, *Gasing* is played at various times and occasions,in the afternoon children and young men usually play *Gasing* after school or recite the Quran. Itis also played on weekends as a way to relax and interact with family and friends. In the celebration of holidays, *Gasing Games* performances are also always presented to enliven the celebration event. Siak District also presents a *Gasing*-playing festival every year to preserve the *Gasing*-playing culture (Hamidy, 2014). The *Gasing Uri* competition is carried out in the same way starting with throwing a spinning *Gasing* to the ground, field, or arena that has been prepared. Whichever spinning *Gasing* is the longest-lasting one wins. With a note, all spinning *Gasing Games* rotate normally. It means that the *Gasing* does not *locong*, which spins upside down or crested down, and does not get out of the agreed arena line (Hamidy, 2014; Rahman, 2012).

The Gasing Pangkah competition starts with an agreement. Who steps or is steppedfirst. The stepped party rotates the *Gasing* first. While the stepping party rotates and or steps the *Gasing* that has been installed. The stepper wins if the spinning *Gasing* flies far, the winning value increases if the spinning *Gasing* becomes a bell. And the spinning *Gasing* breaks. The stepping party wins if the stepping spinning *Gasing* is the one that bounces and flies away and *Gasing* spins first if the stepping *Gasing* is *locong* (spinning upside down or crested down, and does not get out of the agreed arena line) if the stepping *Gasing* does not hit the target (Hamidy, 2014; Rahman, 2012).

The *Paduk Gasing* competition is held, in addition to the durable (*uri*) and *pangkah* fights, there is also a game of spinning fast on the *paduk* board, *upih pinang* or coconut stretched, or even on the palm. The *paduk* board is prepared in advance. A thin board is better. It should beabout a cubit long. It is even better if it is made with a stem, like a badminton ball kicker board. The way to play this creation, the spinning *Gasing* is first played on the ground or floor, by jerking theligates. When the spinning *Gasing* is spinning the player with both palms of his hands in the blink of an eye moves it to the *Gasing* of the *tapuk* board. The more skillful the player is at moving the spinning *Gasing*, the longer it will stay spinning on the *paduk* board. Conversely, if you are not good at playingon this *paduk* board, the spinning *Gasing* stops immediately.

In general, the local knowledge and scientific knowledge of the community regarding the *Gasing Games* is presented in Table 3. Analyze the physics concept of the components of the spinning *Gasing* and the process of playing the spinning *Gasing*, starting from the shape and texture of the spinning *Gasing***.** The symmetrical shape of the spinning *Gasing* and the downward cone make the mass of the spinning *Gasing* concentratedat one point.

The spinning *Gasing* has a low mass center and distributes the mass evenly around the axis of rotation. The even mass distribution increases the moment of inertia, making it resistant to changes in angular velocity.

Table 3: Indigenous and Scientific Knowledge of *Gasing* Game

Theme	Indigenous knowledge	Scientific Knowledge
Gasing Shape: *Gasing* as a traditional game has various shapes to enliven the game.	The shape of the *gasing* comes from the shape of the fruit and the heart of the banana because the shape of the *gasing* is like the fruit, inwhich the cones are down optimally to produce a stable and long rotationof the *gasing*.	The symmetrical shape of the *Gasing* and the downward slope of the *Gasing* make the mass of the *Gasing* concentrated at one point. The *Gasing* is low mass centered and distributes the mass evenly around the axis of rotation. The even mass distribution increases the moment of inertia, making it resistant to changes in angular velocity, thus making the *Gasing* rotation easier, longer, and more stable. The smooth and aerodynamic shape of the *Gasing* helps to reduce the friction force between the *Gasing* and the ground. Friction is a force that opposes the relative motion or tendency of such motion of two surfaces in contact. For a *Gasing*, friction acts between the top and the ground. Frictional Force (f) **u** can be modeled as: $$f = \mu N$$ μ is the coefficient of friction (static or kinetic, depending on whether the top is sliding or rolling). N is the normal force (equal to the gravitational force if the surface is horizontal, N= mgN where m is mass and g is acceleration due to gravity). A smoother and more aerodynamic shape reduces the effective contact area and thus the coefficient of friction μ, resulting in a smaller frictional force f. The smaller the friction force, the longer the spinning *Gasing* will spin. The disc-like shape of the *Gasing* has a smaller surface, so it experiences less friction.
Ropes: The rope for spinning *Gasing* has a certain length to spin the *Gasing* so that it spins longer and the material for *Gasing* rope is rough and not easy to break.	*Gasing* ropes are made from tree bark in Riau because they are strong and durable. Tree bark is a natural material that is easily available, and has cultural values that reflect the community's close relationship with nature and local wisdom in utilising natural resources.	The choice of rough ropes for spinning *Gasing* is because rough ropes have a rougher surface, which increases the static and kinetic friction between the rope and the player's hand. Static Friction is the frictional force that must be overcome to start the motion of an object. It is defined as: $$f_s \leq \mu_s \cdot N$$ where fs is the static frictional force. μs is the coefficient of static friction and N is the normal force. Kinetic Friction: Once the object is in motion, kinetic friction acts on it. It is given by: $$f_k = \mu_k \cdot N$$ Where $f_k$is the kinetic frictional force and μ_k is the coefficient of kinetic friction. Static friction helps the player grip the rope more firmly while spinning the *Gasing*. Kinetic friction helps transfer energy from the player's hand to the *Gasing* more effectively, allowing the *Gasing* to spin faster. The coarse string helps to increase the moment of inertia of the spinning *Gasing* by adding mass to the outside of the spinning

Theme	Indigenous knowledge	Scientific Knowledge
		Gasing. This increase in moment of inertia makes the spinning *Gasing* more stable as it rotates and more resistant to disturbances. The greater the moment of inertiaof an object, the harder it is to change its rotational motion. As the *Gasing* is rotated, the coarse rope helps to maintain the speed of the *Gasing* 's rotation because it reduces the air resistance experienced by the spinning *Gasing*. Air resistance can slow down the spinning *Gasing* 's rotation, making it spin longer.
How to play a spinning *Gasing*: the Malay people of Riau play the spinning *Gasing* with a certain technique so that the spinning *Gasing* rotates for a long time when played.	A spinning *Gasing* is played by wrapping a rope around the *Gasing* and then releasing the rope by throwing the *Gasing* onto the floor with force or using great force so that the *Gasing* can spin fast and long.	A *Gasing* is played by throwing it hard. When *Gasing* is thrown fast, the rotational speed of the *Gasing* increases. The angular velocity is a measure of how fast the Gasing is spinning. It increases when the Gasing is thrown with greater speed: $\omega = \frac{v}{r}$ ω is the angular velocity. v is the linear velocity of a point on the Gasing. r is the radius of the Gasing from its axis of rotation. Angular momentum is a measure of the rotational motion of the Gasing. It is given by: $L = I \,.\, \omega$ $L$is the angular momentum. I is the moment of inertia of the Gasing. ω is the angular velocity. This increase in rotational speed increases the angular momentum of the *Gasing*. The large angular momentum makes the *Gasing* more stable as it rotates and more resistant to disturbances. When a *Gasing* is thrown hard, it has translational kinetic energy. This kinetic energy is transferred from the translational motion of the *Gasing* as it is thrown to the rotational motion of the *Gasing* as it spins. The greater the initial kinetic energy, the greater the rotational energy of the *Gasing*. This large rotational energy allows the *Gasing* to spin faster and longer.

Thus, it makes the spinning *Gasing* rotate easier, longer, and more stable. Based on the analysis of physical concepts from the observation of the resistance of a spinning *Gasing*to changes in its rotational motion, it is analyzed from the physical formula of the moment of inertia that:

$$\boldsymbol{I = \sum m\, R^2}$$

The moment of inertia is directly proportional to the mass (m) and the square of the distance (R) of the mass element from the axis of rotation. With (m) as the mass of the small element and (R) as the distance of the small element from the axis of rotation, the more concentrated the mass near the axis of rotation, the greater the moment of inertia. The large moment of inertia makes the *Gasing* more resistant to changes in angular velocity, so the *Gasing* rotates easily, longer, and stably. The smooth and aerodynamic shape of the *Gasing*, presented in Figure 5a, helps to reduce the friction force between the *Gasing* and the ground. The smaller the friction force, the longer the *Gasing* willspin.

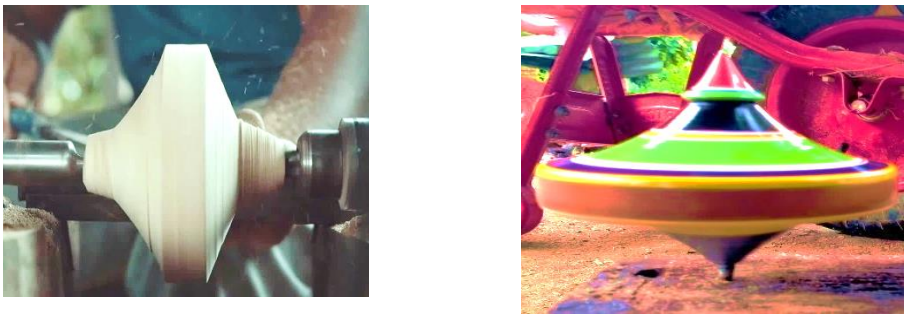

Figure 5. (Left) The process of smoothing the *Gasing*; (Right) The shape of the *Gasing*

The disc-like shape of the spinning *Gasing*, presented in Figure 5b, has a smaller surface, so it experiences a smaller frictional force. Based on the observation of the *Gasing*, the physical formula of friction force is analyzed:

$$F_{friction} = \mu N$$

The friction force is directly proportional to the coefficient of friction (μ) and the normal force (N). The normal force is the force that presses the *Gasing* against the surface. The smaller the surface of the *Gasing*, the smaller the normal force, resulting in a smaller friction force. Gasing ropes are made from tree bark in Riau because they are strong and durable. Tree bark is an available natural material and has cultural values reflecting the community's close relationship with nature and local wisdom in utilising natural resources. However, because the bark takes a long time to be processed into rope, the bark rope is replaced with a rough nylon rope, presented in Figure 6.

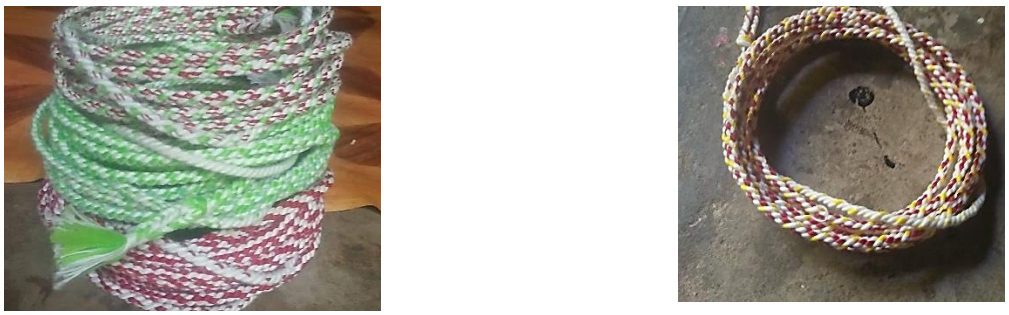

Figure 6. The rope used to play Gasing

The choice of rough ropes for spinning *Gasing*s is because rough ropes have a rougher surface,which increases the static and kinetic friction between the rope and the player's hand. Static friction helps the player grip the rope more firmly while spinning the *Gasing*. Kinetic friction helps transferenergy from the player's hand to the *Gasing* more effectively, allowing the *Gasing* to spin faster.

$$F_s = \mu_s N$$

The formula shows that the static friction force is proportional to the normal force (N) andthe coefficient of static friction (μs). When the player holds the rope before spinning the *Gasing*, thereis static friction between the rope and the hand. A large coefficient of staticfriction allows the player to grip the rope more firmly so that the *Gasing* does not come off easily**.**

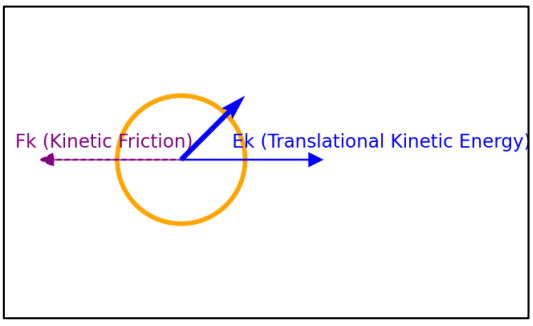

Figure 7. Kinetic friction force and translational kinetic energy on the *Gasing* when released from the rope

When the player spins the *Gasing* by releasing the *Gasing* from the string, presented in Figure 7, there is kinetic friction between the string and the *Gasing*. A large coefficient of kinetic friction helps

transferenergy from the player's hand to the *Gasing* more effectively.

$$F_k = \mu_k N$$

The formula shows that the kinetic friction force is proportional to the normal force (N) and the kinetic friction coefficient (μk). The energy transferred from the player's hand to the *Gasing* is converted into the rotational kinetic energy of the *Gasing*.

$$K = \frac{1}{2} I \omega^2$$

The formula shows that the kinetic energy of rotation is proportional to the moment of inertia (I) and the square of the angular velocity (ω). The coarse string of the *Gasing* helps to increasethe moment of inertia of the *Gasing* by adding mass to the outside of the *Gasing*. This increase in moment of inertia makes the *Gasing* more stable as it rotates and more resistant to disturbances. A large moment of inertia helps the *Gasing* maintain its rotation for longer. Analyze the concept of physics from the observation of the process of playing a *Gasing*. A spinning *Gasing* is played by throwing it hard. When the *Gasing* is thrown hard, therotational speed of the *Gasing* increases. This increase in angular velocity (m) of rotation increases the angular momentum (L) of the *Gasing*, which is shown by Formula.

$$L = I \omega$$

The large angular momentum makes the *Gasing* more stable while spinning and more resistantto disturbances. It allows the *Gasing* to spin longer without tipping over or coming to a halt.

Based on the analysis of the physics concept of the kinetic energy of a spinning *Gasing*. Whena spinning *Gasing* is thrown fast, it has translational kinetic energy due to its motion, presented in Figure 7. (EK_{trans}) due to its motion. When the spinning *Gasing* starts to rotate, the translational kinetic energy (EK_{trans}) is converted into rotational kinetic energy (EK_{rot}). The amount of rotational kinetic energy (EK_{rot})depends on the moment of inertia (I) and angular velocity (ω) of the *Gasing*. The greater the initial kinetic energy (EK_{trans}), the greater the initial kinetic energy, the greater the rotational kinetic energy (EK_{rot}) that is generated. Rotational kinetic energy (EK_{rot}) allows the *Gasing* to spin faster (high angular velocity (ω)) and longer. Conversion of translational kinetic energy (EK_{trans}) into rotational kinetic energy (EK_{rot}) occurs due to the moment of force acting on the *Gasing*. This moment of force causes the *Gasing* to spin and converts translational kinetic energy into rotational kinetic energy. (EK_{trans}) into rotational kinetic energy (EK_{rot}).

Furthermore, the identified physics concepts are linked to the BasicFramework and Junior High School Curriculum to group the relevant Basic Competencies (KD) of Junior High School Physics. The grouping of KD is done by considering the suitability of physics concepts with junior high school physics learning materials listed in the curriculum. The level of difficulty of physics concepts follows the ability of junior high school students. The possibility of applying physics concepts in junior high school physics learning that is interesting and meaningful to students.

To determine the curriculum-specific KD (Basic Competencies) (Merdeka Curriculum) that are aligned with physics concepts related to the *Gasing* game, after analyzing the KD that is by the discussed physics concepts in Table 4.

Table 4. Basic Competencies in junior high school physics learning related to the physics concept of the Gasing game

Basic Competencies in Grade 7:
• **3.6:** Explain the concept of balance and stability of objects in various situations.
• **3.7:** Explain the concept of rotational motion and its quantities.
• **3.8:** Explain the concept of momentum and the law of conservation of momentum.
Basic Competencies in Grade 8:
• **3.8** Understand the concepts of kinetic energy and momentum in a straight-movingobject
• **3.9** Analyse the relationship between kinetic energy and momentum in a straight-moving body
• **4.6:** Analyse the relationship between friction and the motion of objects
• **4.8** Understand the concept of kinetic energy and moment of inertia in rotating bodies
• **4.9** Analyse the relationship between kinetic energy and moment of inertia in rotatingbodies

The results of the Basic Competencies analysis and grouping are then used to develop ethnoscience-based physics learning. This learning is expected to help students understand physics concepts easily, be fun, and increase their love and appreciation for local culture. This research intended to contribute in several ways, namely increasing understanding of the *Gasing* game as a traditional game of Malay Riau, revealing physics concepts, understanding of the *Gasing* game and its relation to the ethnoscience of Malay Riau, developing physics learning based on *Gasing* game, Enriching the cultural treasures of the Indonesian nation. This research is also

expected to develop physics learning based on local culture in other regions in Indonesia.

CONCLUSION

Gasing as a traditional folk game is part of Malay culture and is still preserved in Siak District, Riau Province. This game is a tradition and is usually carried out by young people after work or children after school. However, since this habit is starting to disappear in the Malay community, Siak District organizes a *gasing* festival and displays gasing in every holiday celebration in Riau Province. Gasing is made of hard merbau wood, while the rope is made of *bebaru* tree bark, but now nylon rope is more commonly used. The shape of the *Gasing* originally came from a *berembang* fruit, but now has various shapes such as pumpkin, banana heart, and flying saucer. A *Gasing* consists of a head, body, and legs (axis). There are several types of *Gasing* competitions. From observing the process of playing the *Gasing*, it found physics concepts such as balance, mass distribution, friction force, moment of inertia, rotational motion, angular momentum, kinetic energy, and surface area. This study focuses exclusively on identifying these basic physics concepts inherent in the game of gasing. And, it does not encompass the evaluation of its implementation as a physics learning tool in schools.

Despite the limited scope, the research highlights the significant potential of gasing as a local wisdom-based game to enhance physics learning. The integration of these physics' concepts within the game positions *gasing* as a promising ethnoscience-based resource for science-physics education. Developing *gasing*-based learning aids, such as computer simulations or mobile applications, could serve as an intriguing alternative for facilitating the understanding of physics concepts in educational settings.

REFERENCES

Algiffari, M. (2015). Perancangan motion graphic (bumper in) dan video dokumenter permainan tradisional Jawa Barat (analisis deskriptif permainan tradisional pada Sanggar Seni Tikukur Majalengka). *Jurnal sketsa*, *2*(1).

Amri, Y. K. (2022). Folklor Etnik Kearifan Lokal Etnik Sebagai Bias Nilai Budaya. *Kumpulan Berkas Kepangkatan Dosen.*

Angrayni, M. (2021). *Keberadaan Tari Persembahan Dalam Acara Penyambutan Di Kampung Benayah Kecamatan Pusako Kabupaten Siak Provinsi Riau* (Doctoral dissertation, Universitas Islam Riau).

Artis, A. (2018). Branding "Siak The Truly Malay" Oleh Dinas Pariwisata Kabupaten Siak. *Komunikasiana: Journal of Communication Studies*, *1*(1).

Astuti, I. A. D., & Bhakti, Y. B. (2021). Analisis Konsep Fisika pada Permainan Tradisional Gasing sebagai Bahan Ajar Fisika. *Navigation Physics: Journal of Physics Education*, *3*(2), 74-79.

Azhar, A. A., Zubir, M. F., Mohd Shafie, M. F., Bunawan, A. A., & Azman, K. A. (2019). Tokoh gasing pangkah Selangor/Ahmad Ammar Bin Azhar. *Jurnal Sejarah Lisan Malaysia (JSLIM)*, *3*(1), 56-68.

Cendana, H., & Suryana, D. (2022). Pengembangan permainan tradisional untuk meningkatkan kemampuan bahasa anak usia dini. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini*, *6*(2), 771-778.

Creswell, John W. & Guetterman, Timothy C. (2019). Educational Research Sixth Edition. Planning, Conducting, and Evaluating Quantitative and Qualitative Research. New York : Pearson

Dewi, R. M., & Mailasari, D. U. (2020). Pengembangan Keterampilan Kolaborasi pada Anak Usia Dini melalui Permainan Tradisional. *ThufuLA: Jurnal Inovasi Pendidikan Guru Raudhatul Athfal*, *8*(2), 220-235.

Febriyanti, C., Prasetya, R., & Irawan, A. (2018). Etnomatematika pada permainan tradisional engklek dan gasing khas kebudayaan sunda. *Barekeng: Jurnal Ilmu Matematika Dan Terapan*, *12*(1), 1-6.

Fibiona, I. (2021). Cublak Cublak Suweng Dan Gobak Sodor: Pengembangan Karakter Anak Dalam Permainan Tradisional Yogyakarta. *Dinas Kebudayaan (Kundha Kabudayan) DIY*.

Fikraturrosyida, V. (2018). *Perancangan Ambient Media Sebagai Sarana Promosi Permainan Tradisional Komunitas Anak Bawang Surakarta* (Doctoral dissertation, Fakultas Seni Rupa Dan Desain).

Gifani, A. G., Novianti, W., Nabila, L., & Bhakti, Y. B. (2023). Pengembangan Aplikasi Etnofisika Berbasis Android Pada Permainan Tradisional Gasing Untuk Meningkatkan Pemahaman Konsep Fisika Siswa. *Jurnal Inovasi dan Pembelajaran Fisika*, *10*(1), 74-83.

Hamidy, UU. 2014. Jagad Melayu dalam Lintas Budaya di Riau. Pekanbaru: BIlik Kreatif Press.

Harahap, N. S., & Jaelani, A. (2022). Etnomatematika pada Permainan Tradisional Engklek. *Paradikma*, *15*(1), 86-90.

Herman, H., & Bachtiar, M. Y. (2018). Permainan Tradisional dalam Era Globalisasi:

Menumbuhkembangkan Kemampuan Anak Usia Dini.

Intan, Taslim E. Datuk Mogek dan Junaidi Syam. (2007). Trombo Rokan. Pasir Pengarayan: Yayasan Garasibumy

Jasman Ahmad, Siti Zaiton, & Sulaiman Zakaria. (1996). Gasing dan congkak (Cet.1). Setiamas.

Kementrian Pendidikan dan Kebudayaan. (2019). *Kemendikbud Tetapkan 267 Warisan Budaya Tak Benda.* Retrieved from https://www.kemdikbud.go.id/main/blog/2019/10/kemendikbudtetapkan-267-warisan-budaya-takbenda

Kristanto, A. (2020). Urgensi kearifan lokal melalui musik gamelan dalam konteks pendidikan seni di era 4.0. *Musikolastika: Jurnal Pertunjukan Dan Pendidikan Musik*, *2*(1), 51-58.

Laini, A., Azizah, W., & Hardisa, A. (2023). Penanaman Karakter Anak Usia Dini Dalam Permainan Tradisional Pangkak Gasing. *Jurnal Adzkiya*, *7*(2), 1-8.

Mulyaningsih, N. N., Jahrudin, A., Astuti, I. A. D., & Okyranida, I. Y. (2023). *Etnofisika dalam Seri Permainan Tradisional*. Syiah Kuala University Press.

Ningtiasih, S. W., Syahrial, S., & Kurniawan, A. R. (2020). *Analisis Permainan Tradisional Daerah Kabupaten Sarolangun Dalam Proses Pembelajaran Di Sekolah Dasar* (Doctoral dissertation, Universitas Jambi).

Pangestu, H. D., Annur, S., & Sholahuddin, A. (2020). Development of integrated natural science module with local content in wetland environment to train science process skills for 8th grade students of SMP N 23 Banjarmasin. *Journal of Science Education Research*, *4*(2), 81-94.

Permadi, A., & Nur, L. (2021). Pelestarian Permainan Tradisional melalui Model Pembelajaran SPADE. *Pedadidaktika: Jurnal Ilmiah Pendidikan Guru Sekolah Dasar*, *8*(1), 83-90.

Primaharani, S., Widiyawati, Y., & Sari, D. S. (2024). "Dingklik Oglak Aglik" Traditional Games Integration in Science Teaching Module to Promote Global Diversity. *Journal of Science Education Research*, *8*(1), 77-91.

Putra, I. W. W. E., Wiranatha, A. K. A. C., &Piarsa, I. N. (2016). Rancang Bangun Game Tradisional "Adu Gasing" Pada Platform Android. Jurnal Ilmiah Merpati (Menara Penelitian Akademika Teknologi Informasi).

Rahman, Elmustian dkk. 2012. Ensiklopedia Kebudayaan Melayu Riau. Pekanbaru: Pusat Penelitian Kebudayaan dan Kemasyarakatan Universitas Riau

Rahman, Elmustian. 2008. Penyusunan Profil dan Deskripsi Adat Istiadat Daerah (Reidentifikasi Tradisi Lisan Melayu Kabupaten Bengkalis). Pekanbaru: Tenas Effendy Foundation.

Safitri, A., Hermandra, H., & Sinaga, M. (2020). Metafora Kata Buah dalam Bahasa Melayu Dialek Mempura Kabupaten Siak: Kajian Semantik Kognitif. *Madah: Jurnal Bahasa dan Sastra*, *11*(2), 161-172.

Sanjayanti, N. P. A. H. (2022). *Model Pembelajaran IPA Bermuatan Kearifan Lokal Bali untuk Meningkatkan Karakter dan Literasi Sains*. Nilacakra.

Siahaan, J. M., & Sundhari, S. (2019). Studi Pemanfaatan Huma Betang Tumbang Manggu Sebagai Sumber Pembelajaran Olahraga Tradisional Di Kalimantan Tengah. *Riyadhoh: Jurnal Pendidikan Olahraga*, *2*(2), 1-10.

Sintauri, B. D., Puspitasari, A. D., & Noviyanti, H. (2020). Kajian Etnomatematika Pada Permainan Gasing Yang Dijual Di Malioboro Yogyakarta. In *Prosandika Unikal (Prosiding Seminar Nasional Pendidikan Matematika Universitas Pekalongan)* (Vol. 1, pp. 419-428).

Sufa, D. P., Amir, A., & Gani, E. (2021). Pendidikan Budaya Dan Karakter Dalam Buku Pendidikan Budaya Melayu Riau Kelas VII Smp. *JP (Jurnal Pendidikan): Teori dan Praktik*, *6*(2), 87-93.

Sutini, A. (2018). Meningkatkan keterampilan motorik anak usia dini melalui permainan tradisional. *Cakrawala Dini: Jurnal Pendidikan Anak Usia Dini*, *4*(2).

Warli, D., & Musa, S. (2022). Eksplorasi Etnomatematika Dan Etnosains (Etnomathsains) Pada Batik Bomba. *Koordinat Jurnal Pembelajaran Matematika dan Sains*, *3*(1), 33-38.

Winarsih, E. (2017). Permainan Tradisional "Engkling" untuk Meningkatkan Keterampilan Berbahasa, Interaksi Sosial, dan Sarana Pendidikan Anti Korupsi pada Siswa Sekolah Dasar di Kota Madiun. *Widyabastra: Jurnal Ilmiah Pembelajaran Bahasa dan Sastra Indonesia*, *1*(2), 1-18.

Yuliana, Y., Nurwahidah, I., & Widiyawati, Y. (2023). Development of ethno-STEM learning module based on javanese gamelan. *Journal of science education research*, *7*(2), 130-139.