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Exploration of physics concepts with traditional *engklek* (hopscotch) game: Is it potential in physics ethno-STEM learning?

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ABSTRACT

Engklek, is one of the traditional games that have many physics concepts to explore, and has the potential to be applied in Ethno-STEM-based physics learning. So far, no study has been carried out on exploring the physical concept of this game. Hence, this study aims to explore the concepts of physics in traditional *Engklek* games and its potential applications in Ethno-STEM-based physics learning. This study uses a qualitative research method with an exploratory design. Data collection using three methods: observations, interviews, and literature studies. Data were analyzed descriptively through three stages: data reduction, presentation, and verification or inference. The results show that the main physics concepts contained in this game are parabolic motion; work and energy; momentum and impulse; and equilibrium of the rigid body. This game also can be applied to physics learning because it is relevant to the 2013 curriculum and the Ethno-STEM review. Therefore, the *Engklek* game can be more meaningful, fun, interactive, and contextual physics learning media. This research implies that the results of exploration and analysis of its potential application to Ethno-STEM-based science learning can be tested for future research or applied directly to physics learning. It is hoped that this learning can increase students' learning motivation while preserving the local wisdom game of *Engklek*.

INTRODUCTION

Engklek is one of the traditional games brought by the Dutch to Indonesia (Prihastari, 2015). But actually, this game has existed since the time of the Ancient Roman Empire and has a foreign name Hopscotch (Tzeng & Huang, 2010). This game is done by throwing *gaco* sequentially on each swath made, then the player jumps using one foot in each swath. Thus, this game requires skill, precision, and balance to complete its objectives. This game can train affective, psychomotor, problem-solving skills and explore one's solutions while playing (Iswinarti, 2016; Ulfatun et al., 2020). Even so, this game is increasingly being abandoned by today's children, and some have never even known and played it (Putri & Hasyim, 2017; Utami et al., 2018). Unfortunately, the game, one of Indonesia's local wisdom, is marginalized and forgotten.

One of the efforts to preserve the *Engklek* game is to integrate it with learning, especially physics, because if explored further, the *Engklek* contains many physics concepts. If this game can be integrated into one of the physics learning media, it can help students understand physics because it is based on contextual, recreational, and fun local wisdom (Laksana & Rabu, 2015; Sukma et al., 2019; Wijayanti, 2016).

The application of the *Engklek* game in physics learning can be integrated learning of Ethno-STEM (Ethnoscience, Science,

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Technology, Engineering, Mathematics) because it combines local wisdom into STEM (Sudarmin et al., 2018). STEM is also very relevant to the latest 2013 Curriculum with student-centered learning (Gale et al., 2020; Maryani et al., 2021; Roehrig et al., 2021; Tan & Leong, 2014). One of the functions of local wisdom is to preserve the cultural values to become a character education (Sudarmin, 2014). In the *Engklek* game, cultural values used as character education are togetherness, sportsmanship, and discipline (Hidayat, 2013; Nugrahastuti et al., 2012). So that the application of the *Engklek* game in Ethno-STEM-based physics learning is very positive and has many benefits. This is supported by previous research showing that the application of Ethnoscience and Ethno-STEM-based learning can effectively improve students' scientific literacy (Dewi et al., 2019; Wati et al., 2021), scientific skills (Hastuti et al., 2019), learning outcomes (Usman et al., 2019), entrepreneurship (Sudarmin et al., 2017), science process skills (Ibe & Nwosu, 2019), scientific character (Atmojo et al., 2019), critical, and creative thinking skills (Risdianto et al., 2020; Sumarni & Kadarwati, 2020).

Several studies have been conducted by (Febriyanti et al., 2018; Irawan, 2018; Ulfatun et al., 2020; Mulyasari et al., 2021; Supriadi & Arisetyawan, 2020) have applied the *Engklek* game, but only in learning mathematics in early childhood. In addition, other research conducted by (Sari et al., 2019; Sari et al., 2020) explained the physics concepts in the *Engklek* game only on the material of parabolic motion, impulses, and momentum only. If explored further, this game contains a lot of other physics concepts and has the potential to be applied in learning. However, the existing research has not fully explained the potential for applying the *Engklek* game in physics learning following the curriculum. So, there is a need for research on the exploration of more in-depth physics concepts in the *Engklek* game so that this research can contribute to maintaining the existence and introduce this traditional game to children today. In addition, the application of *Engklek* in learning physics will be more meaningful because it is contextual, recreational, and fun.

Therefore, this study aims to explore in more detail the physics concepts in traditional *Engklek* games and their potential applications in Ethno-STEM-based physics learning. The difference between this research and previous research is the further exploration of the concept of physics as well as analyzing its potential application in Ethno-STEM-based physics learning. The results of this study are expected to be applied in the physics learning process to improve students' understanding and preserve one of Indonesia's local wisdom.

METHODS

This study uses a qualitative research method with an exploratory design to map an object relatively deep (Sugiyono, 2020). In this case, the exploration of the concept of physics in the *Engklek* game. The research stages can be seen in Figure 1.

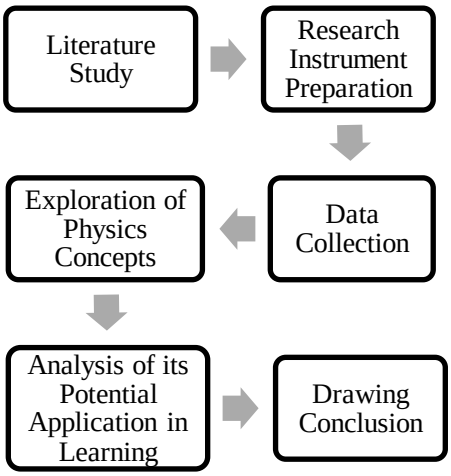

Figure 1. Research stages

The sampling technique used in this study is the purposive sampling method (Arikunto, 2010). The sample selected was two student friends not from the physics department. The reason for choosing friends is that the relationship between the researcher and the sample is more open and trusting each other,

so there is no more hidden information (Sugiyono, 2020). In addition, the selection from outside the physics department to know respondents' perceptions naturally and not tied to the science of physics.

The first sample (player) was named IRU (female) from Madiun Regency, East Java. He is currently a student in Education Management class 2019. Then the second sample is named MFR (male), who comes from the city of Surabaya, East Java. He is currently a 2019 Electrical Engineering student. These two samples are very relevant to this research topic because they are not from the physics department, have different gender, and come from different areas.

This study's data collection techniques used interviews, observation, and literature review. Interviews and observations were conducted directly with two samples on November 17, 2021. The interviews were conducted in a structured, alternating manner and had the same questions according to the research objectives of (Rachmawati, 2007). The question rubric is prepared using everyday language and is easily understood by the interviewee. The topic of the question includes the interviewee's perception of the *Engklek* game, which is adapted to several physics concepts.

Observational data collection was carried out in a structured manner by asking the sample to play the *Engklek* game one turn in turn in order to observe the physical concept (Hasanah, 2017). The results of the observations were then documented and analyzed for physics concepts related to the *Engklek* game.

Finally, data collection was carried out using a literature review to obtain or dig more profound and more detailed information through the results of previous studies (Snyder, 2019). The literature review is carried out by looking for 13 books or journal articles as references that discuss the *Engklek* game, the concept of physics in the *Engklek* game (previous research), and related physics concepts (i.e. Parabolic Motion, Rigid Body Balance, Work, and Energy, also Momentum and Impulse). There are no significant inclusion and exclusion criteria in the references used because the literature review is only used to support the theory that has been explored in the *Engklek* game.

After three data collection techniques were carried out, the data was triangulated to strengthen the findings (Bunyamin et al., 2020). First, data obtained through interviews will be cross-checked through observations of the sample. If there are similarities between the results of the interviews and the observations, this can strengthen the findings obtained. After that, the findings in the form of physics concepts according to the researcher's view will be analyzed according to the literature review results to strengthen the final findings. So, data collection through interviews, observations, and literature reviews was triangulated.

The data obtained were then analyzed descriptively to overview the research results and findings obtained (Yuliani, 2018). Next, qualitative descriptive data analysis was carried out through three stages: data reduction, data presentation, and data verification or inference (Rijali, 2019). The final data obtained is the result of exploring the concept of physics in the *Engklek* game. After that, the physics concepts in the *Engklek* game will be analyzed for their relevance to the latest high school physics curriculum. Finally, the potential application of *Engklek* as a media for learning physics is more fun while preserving this traditional game (Sholahuddin & Admoko, 2021).

RESULTS AND DISCUSSION

Overview of The *Engklek* Game

The game begins by making a "plane" shaped plot using chalk (for hard soils) or a pattern on the ground directly (for sandy or soft soils). The plot image made for this research can be seen in Figure 2. After that, the game can be played.

Figure 2. The *Engklek* game swath model in this study is the airplane model.

According to research by Lestari & Siregar (2017), the mechanics and regulations of the *Engklek* game are described as in Figure 3.

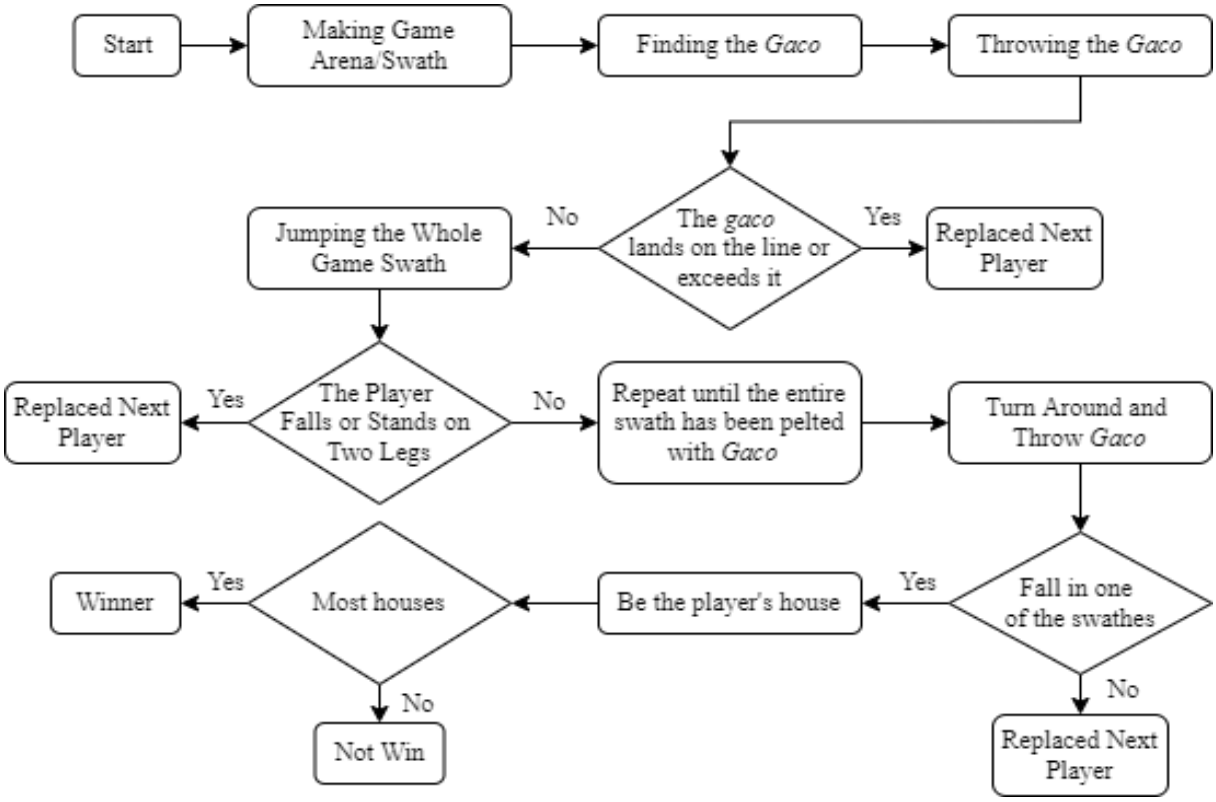

Figure 3. *Engklek* game concept flowchart

1. The first is finding *gaco*, a small object (e.g., a piece of ceramic or stone) that each person relies on. *Gaco*s are then thrown sequentially, starting from the

closest swath (assume the first swath). If the *gaco* lands on the line or exceeds it, the player is disqualified.

2. After that, the player jumps using one foot on the *Engklek* game swath entirely in sequence, then returns and takes the *gaco* in the first swath while standing on one leg. If the player falls or stands on two legs, it will be declared void and replaced by the next player. But if successful, the player can continue the game. The box containing the *gaco* is also not allowed to be stepped on by the player.
3. Each player completes his turn if he has successfully jumped over all the swathes or if the player is declared disqualified. After that, it's another player's turn to throw the *gaco* and jump over the swathes.
4. If a player has succeeded in throwing the *gaco* on the entire swath, the player can throw the *gaco* with his back to the *Engklek* swath. The location where the *gaco* falls on a swath will become the player's swath (house). Players can use two legs on the house they have.
5. The winner is the player who has the most houses.

Based on the results of an interview with IRU, the mechanics of the *Engklek* game are similar in his home area "*starting by throwing gaco, then lifting one leg, then jumping over all the swathes. The box with the gaco is not to be stepped on, it must be passed."* Meanwhile, according to MFR, the mechanics of the Engklek game also have similarities in the area " *Then we are required to jump with one gaco to be thrown and land in one of the intended boxes. Then it is thrown in order from the starting swath to the end. The swathes containing the gaco must not be stepped on and must be jumped on every turn"*. This similarity is because they come from different regions (i.e., Madiun and Surabaya) but are still in the same province (i.e., East Java), so that cultural differences are almost non-existent.

Results of Exploration of Physics Concepts

Based on the results of observations done to the sample, the concepts of physics in the *Engklek* game can be found as shown in Table 1. The table shows that four physics concepts can be explored: parabolic motion, rigid body balance, energy, momentum, and impulse.

Table 1. Results of exploration of physics concepts in the *Engklek* game

Physics Concepts	Activity	Description and Theory
Parabolic Motion	Throwing *gaco* to a swath	When *gaco* is tossed, players must determine the initial speed of the *gaco*, which is adjusted to the swath to be addressed. This is following Eq. (1), where the farthest distance traveled by the *gaco* will be affected by the magnitude of the initial velocity of the *gaco* when thrown (Rosyid et al., 2016). $x_{horizontal} = v_0 \cos \alpha t$ (1)
Rigid Body Equilibrium	Stand on one leg on each swath without falling	When a player is on each swath, the player must stand on one strongest leg and not fall. This follows the particle equilibrium theory such as Eq. (2&3), where the player must strive so that the force and torque acting on his body must be zero so that the player does not fall (Serway & Jewett, 2014). $\sum F = 0$ (2) $\sum \tau = 0$ (3)
Work and Energy	Jumping from one swath to another	When a player is going to jump over a swath, the player needs a repulsion force which will affect the player's movement. Therefore, following the concept of energy directly proportional to displacement, such as Eq. (4), if the player wants to get a protracted

Physics Concepts	Activity	Description and Theory
		displacement when jumping, then the energy required by the player will be greater (Halliday et al., 2014). $W = F.s$ (4)
Momentum and Impuls	*Gaco* hitting another *gaco* in a swath or tile	When a player throws a *gaco* on a swath and hits another player's *gaco*, a partially elastic collision will occur ($0 < e < 1$) as in Eq. (5), the change in momentum (impulse) as Eq. (6), and the velocity after experiencing the collision as Eq. (7) (Lasmi, 2016). $e = \frac{-(v_1' - v_2')}{v_1 - v_2}$ (5) $I = \Delta p = m(v_2 - v_1)$ (6) $m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2'$ (7)

1. Parabolic Motion

Based on the results of the sample observations as shown in Figure 4, it can be seen that MFR throws *gaco* in one of the swaths he is aiming for. When MFR completes his first turn on the nearest swath, the swath he aims for will be farther away, so he has to throw the *gaco* further. The farther the *gaco* throw distance, the MFR must throw the *gaco* with a greater initial speed. During the interview, this was confirmed by him: "*every swath from start to finish has a different distance, so there needs to be an estimate (indirect calculation) when throwing gaco*". IRU also confirmed the same thing "*if the swathes are further away, the force used to throw them also increases, and vice versa"*. The style referred to by IRU is the style for throwing *gaco*. If the force to throw the *gaco* gets bigger, then the initial velocity (v_0) of throwing *gaco* will also increase.

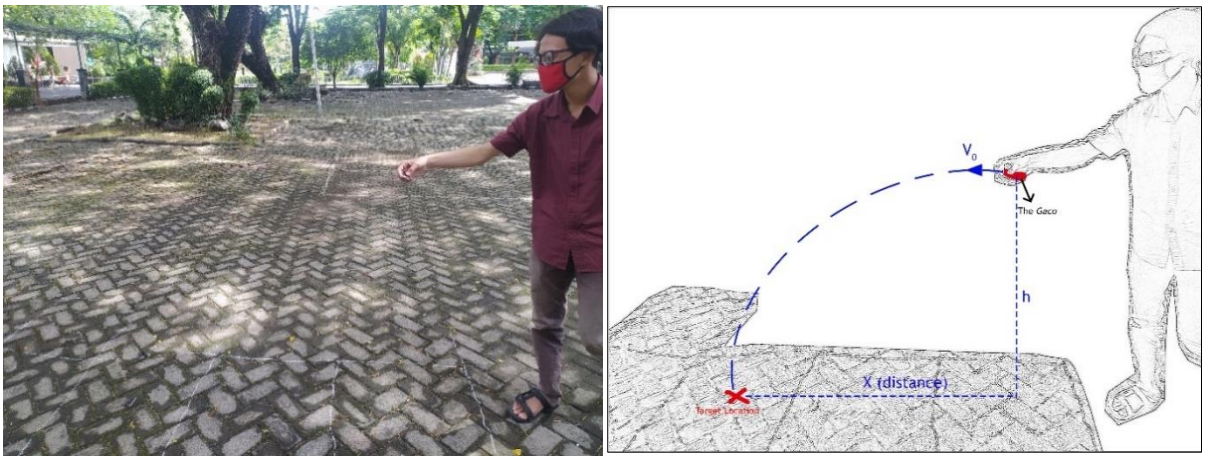

Figure 4. MFR is throwing *gaco* and analysis of the concept of parabolic motion.

Theoretically, the greater the initial velocity is given to the *gaco* when it is tossed, the distance (results) of the throw will be further (Karanggulimu et al., 2019; Lasmi, 2016). The relationship between these two variables is formulated in Eq. (1), where the value of X_{max} (maximum distance traveled) is directly proportional to v_0 (initial speed). In the case of MFR throwing *gaco*, no elevation angle is formed because the position of the *gaco* is at the maximum height, and the direction of the *gaco* will be in the direction of the acceleration of gravity, so the value of cos α = 1. The results of the exploration of the concept of parabolic motion in this game are similar to research (Fuad et al., 2018) which revealed that the game *Baingkaan* (another name for *Engklek* in South Kalimantan) has the concept of parabolic motion. However, this study uses a review of the Y-axis on the equation of motion. So that the study wrote the equation of motion using

a sine, as a result, the value of the *gaco* mileage would be 0 because sin 0 = 0.

2. Rigid Body Balance

Observations show when IRU was standing on one leg on the *Engklek* game swath. According to theory, an object is said to have equilibrium if the value of the translational and rotational balance is equal to zero ($\sum F = 0$ and $\sum \tau = 0$). When IRU stands on one leg, the breakdown of the force occurs as in Figure 5.

Figure 5. IRU is standing using one leg on the *Engklek* swath and exploring the rigid body concept.

Translational Balance

$$\sum F_y = N - W = 0 \qquad (8)$$

$$\sum F_y = m.g - m.g = 0 \qquad (9)$$

Rotational Balance

$$\sum \tau = N \times l \neq 0 \qquad (10)$$

Because the rotational balance conditions are not met, there will be an imbalance in the IRU body. This imbalance is due to the distance l between the foot and the body center of gravity to form a torque or force moment. If the value of $l \neq 0$, they will have a magnitude ($\tau \neq 0$), thus making the body unbalanced. However, this is a challenge and excitement for players because it will be considered a loss if a player falls or stands using two legs.

Based on the results of interviews by IRU and MFR also confirmed this. So the researchers asked further their efforts to minimize this imbalance. According to IRU, "*we need balance when we stand on one leg, we must really hold it in order to be balanced, besides that we also have to move quickly so we don't sway and get tired*". Meanwhile, MFR said "*when standing, jumping, or landing, we need to pay attention to the strongest type of foot so that it can be balanced and not fall*." IRU's opinion reveals that the method is to hold it upright and apply more force to the ground to reduce the potential for falling. Still according to IRU, if the foot is used too fast, the player moves, this can minimize the time when standing on one leg to reduce the potential for falling. Meanwhile, according to the MFR, the use of the strongest foot can strengthen the footrest. These findings are similar to research by (Pratiwi & Kristanto, 2015; Rahmanto et al., 2020) which revealed that the *Engklek* game can train balance in players.

3. Work and Energy

According to the theory, a person can have done Work if he applied a force and experienced a displacement (Munasir, 2016), this is written mathematically according to

Eq. (4). When playing *Engklek*, the style in question is the force of foot repulsion on the playing field (ground). When the foot makes a repulsion, Newton's 3rd law applies, where the action force is repulsive, while the reaction force is the force that makes the player jump, as shown in Figure 6.

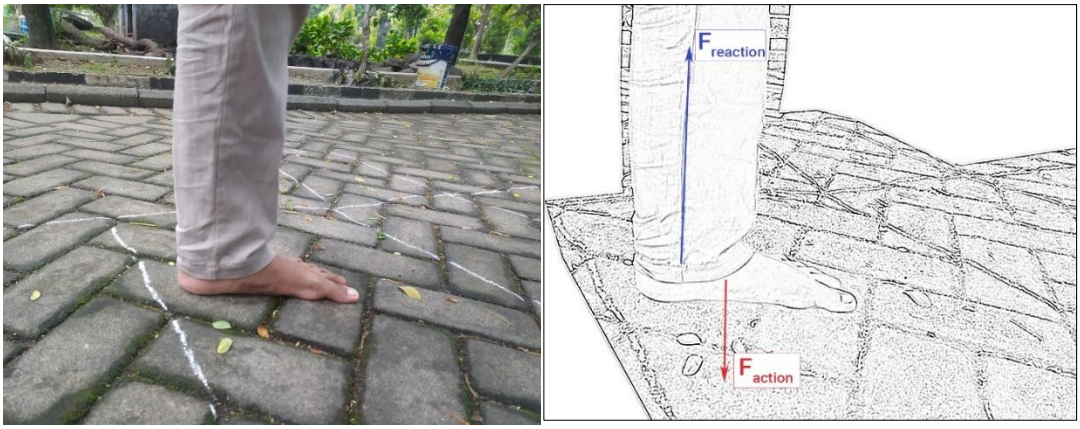

Figure 6. Diagram of Newton's 3rd law of force when the IRU will jump.

The results of the interview by IRU revealed: "*a person's body weight when going to jump greatly affects the repulsion force, the heavier a person's body is, the greater the repulsion required to jump will also be, in direct proportion to"*. On the other hand, the interview results by MFR said that "*repulsion is very important when someone is about to jump, and body weight does not affect it"*. So their two opinions contradict each other. Suppose a person's body is getting heavier. In that case, the force needed to jump must also be large because of the gravitational force that pulls the player's body to the ground, in line with research (Cuk et al., 2014; Huda et al., 2012) which revealed that body weight affects the repulsion force for jumping.

If it is associated with the concept of Work, the repulsion magnitude will affect the movement of players when jumping over a swath. For example, Figure 7 shows when the IRU is jumping over a swath that contains a *gaco* so that it experiences a displacement of *s* from the initial swath to the destination swath. So in the *Engklek* game, the concept of work and energy in question is the product of the player's repulsion force with the distance the player jumps.

Figure 7. Displacement or jump distance when IRU jumps from swath number 1 to 3 over the *gaco*.

4. Momentum and Impulse

In the *Engklek* game, the concepts of momentum and impulse are inseparable, especially in collisions between *gaco*s, as shown in Figure 8. According to IRU *"When a player throws his gaco and hits another*

player's gaco, that player will not get the next turn". Theoretically (Lasmi, 2016), this occurs because of a completely inelastic collision (e = 0) which causes *gaco* to bounce out due to a collision with the thrown *gaco*. At that time, there was a change in momentum of the *gaco,* which was initially at rest (P = 0), but then changed because it was hit by the thrown *gaco* (P > 0). As a result, there is a change in momentum to become like the Eq. (6). In response to this, MFR recommended: *"in choosing gaco it must be adjusted and not too light because other players' gaco can potentially pound it"*. While the concept of impulse occurs when there is a change in momentum of the crushed *gaco*.

Figure 8. The condition of two *gaco*s after the collision has the same final velocity because the type of collision is not elastic at all.

The concept of momentum and impulse in the *Engklek* game is characterized by collisions, changes in momentum, and impulses on *gaco*s. This is in line with research by (Sari et al., 2019; Sari et al., 2020) which showed that the *Engklek* game contained the concepts of momentum and impulse.

Potential Applications in Ethno – STEM based Physics Learning

The analysis of the potential application of the *Engklek* game in physics learning can be reviewed first in terms of the applicable curriculum. Table 2 shows the basic knowledge and skills competencies in high school physics subjects following the 2013 Revised 2018 Curriculum on materials relevant to exploration results. In addition to relevance to the curriculum, an Ethno-STEM analysis was carried out because education with an Ethno-STEM-based approach is one of the integrated multicultural-based physics learning (Tresnawati et al., 2021), which is shown in Table 3. This is important for creating contextual physics learning, fun and preserving the game *Engklek*.

Table 2. Basic competence of knowledge and skills of physics subjects in Minister of Education and Culture No. 37 of 2018 by the material from the exploration of physics concepts in the *Engklek* game.

Grade	Basic Competency (Knowledge)	Basic Competency (Skills)
10	3.5 Analyzing parabolic motion using vectors, along with their physical meanings and their application in everyday life	4.5 Presenting data from parabolic motion experiments and its physical meaning
10	3.9 Analyzing the concept of energy, Work (Work), the relationship of Work (Work) and	4.9 Applying the scientific method to propose ideas for solving motion problems in everyday

Grade	Basic Competency (Knowledge)	Basic Competency (Skills)
	energy changes, the law of conservation of energy, and its application in everyday events	life, relating to the concepts of energy, work (work) and the law of conservation of energy
10	3.10 Applying the concepts of momentum and impulse, as well as the law of conservation of momentum in everyday life	4.10 Presenting the results of testing the application of the law of conservation of momentum, for example, a ball falling freely to the floor and a simple rocket
11	3.1 Apply the concepts of torque, moment of inertia, point weight, and the angular momentum of the rigid body (static and dynamic) in everyday life such as in sports	4.1 Creating works that implement the concept of gravity and equilibrium rigid bodies

At the material parabolic motion (3.5 and 4.5), *Engklek* game can be applied to analyze the components. In addition, many physical meanings can be conveyed to students, such as the angle of throw, initial velocity, and acceleration of gravity related to the throwing distance of the *gaco*. However, quantitative data cannot be obtained from the *Engklek* game in terms of skills because the game is based on feelings (feeling).

In Work and Energy matter (3.9 and 4.9), the *Englek* game can be applied to the Work and Energy sub-materials, including the relationship between Work, force, and displacement; or the concept of energy required to jump and its relationship to body weight. In addition, in terms of skills, the *Engklek* game can be used as a reference in applying scientific methods related to the concept of energy because students can investigate the relationship between variables in Work and energy, such as force and displacement. Students can also practice directly so that they can create meaningful learning.

In the material on momentum and impulse (3.10 and 4.10), it is very clear that the *Engklek* game includes applying the concepts of momentum, impulse, and the law of conservation of momentum when throwing *gaco* and hitting other *gaco*s. In terms of skill competence, the *Engklek* game is also relevant to presenting the testing results applying the law of conservation of momentum, which can be done by deepening the concept of a collision on the *gaco*.

In the rigid body balance material (3.1 and 4.1), the *Engklek* game can be included in the torsion, center of gravity, and rigid body balance sub-topics because it is very relevant to the results of previous explorations. Furthermore, *Engklek* game also includes in sports and recreation, following the directions of the written basic competencies. Hence, in terms of skills, the *Engklek* game cannot be included in the making works because it can only be a learning medium and not a project or Work that students can do.

Based on the analysis results in terms of the curriculum, it can be seen that the *Engklek* game can be included as a learning media based on local wisdom games relevant to parabolic motion physics materials; work and energy; momentum and impulse; rigid body balance. Although not all competencies are relevant to the physics concept due to exploration, applying the *Engklek* game able to make physics learning more fun, and interactive and preserve the *Engklek* game. So far, there has been no research that has applied the *Engklek* game directly to physics learning. However, research by Sari et al. (2020) developing comics for learning physics based on the *Engklek* game can improve students' mathematical representation and creative thinking skills. In addition, research by (Asrial et al., 2020; Utami et al., 2018; Widyastuti et al., 2020) shows that the application of the game *Engklek* is effective in improving student learning outcomes in mathematics and physics learning while at the same time preserving the culture of this game.

According to Table 3, the *Engklek* game fulfills all the Ethno-STEM components when applied to physics learning. This further supports the potential application of the *Engklek* game to fun and interactive local

wisdom-based physics learning. In addition, according to the application of Ethno-STEM, it can improve problem-solving skills, think logically according to the 21st century perspective (for STEM), and develop character education based on local culture (for Ethnoscience) (Afriana et al., 2016; Parno et al., 2019; Shernoff et al., 2017; Sudarmin et al., 2019; Sumarni & Kadarwati, 2020).

Table 3. Ethno-STEM Components in physics learning with the help of the *Engklek* game

Components	Description
Ethno	The local wisdom of the *Engklek* game can be well preserved if applied in physics learning.
Science (S)	Physics concepts applied to the game
Technology (T)	Choosing the right *gaco* can determine the success of a player
Engineering (E)	Designing the playing swath, developing *gaco* selection strategies, gaco throwing, jumping and balance
Math (M)	Analyzing *gaco* throws by swath

In the Science component, the *Engklek* game has many physics concepts that can be applied successfully explored in this research. In the Technology component, the *Engklek* game does not use modern technology but uses traditional 'technology' marked by choosing *gaco*. The choice of *gaco* greatly affects the game's victory because the landing of the *gaco* depends on the surface. The Engineering component requires players to think about the design or strategy of the game to win. The strategy in question can be shifting the player's *gaco*, or a strategy to balance the body when the goal tile is difficult to reach. Finally, in the mathematics component, calculations are carried out indirectly when throwing *gaco*. In accordance with the opinion of MFR which stated that when throwing, the player must indirectly estimate so that the *gaco* falls right on the goal square.

The contribution of this research is to provide new knowledge that many physics concepts can be explored from the *Engklek* game. This exploration of physics concepts can certainly be integrated into Ethno-STEM-based physics learning, which has many benefits for students. This can also create a fun learning atmosphere (edutainment) while at the same time preserving traditional games that are now starting to be abandoned.

CONCLUSION AND SUGGESTION

It can be concluded that the main physics concepts that can be explored in the traditional *Engklek* local wisdom game are parabolic motion; work and energy; momentum and impulse; and rigid body balance. The *Engklek* game can be applied to physics learning because it is relevant to the 2013 curriculum and the Ethno-STEM review. Then, suggestions can be submitted to further researchers to test the application of learning physics assisted by the *Engklek* game so that it can make learning more meaningful, contextual, recreational, and fun. This research implies that the results of exploration and analysis of its potential application to Ethno-STEM-based science learning can be tested for future research or applied directly to learning. It is hoped that this learning can increase students' learning motivation while preserving the local wisdom game of *Engklek*.

AUTHOR'S CONTRIBUTION

IAR: Data acquisition, data analysis, drafting manuscript; NS: Concept and design, technical support; SA: Supervision, final approval.

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