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Exploration of Physics Concepts through the Local Wisdom Traditional Game "Bedil Jepret Bambu"

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Abstract: Physics education in Indonesia tends to be abstract, with the connection between physics concepts and students' everyday experiences often remaining unclear. This study maps the physics concepts embedded in the mechanism of the traditional bamboo snap gun (*bedil jepret bambu*) game as a source of contextual learning. A descriptive qualitative method was employed, based on conceptual analysis of the literature and field data (observation and interviews). The analysis reveals that the mechanism of the bamboo snap gun involves the concepts of elasticity (Hooke's Law), force and acceleration (Newton's Laws), work and energy, impulse and momentum, and parabolic motion. These findings indicate the significant potential of the bamboo snap gun as a physics learning medium that links theory with local cultural contexts. In conclusion, this conceptual mapping can serve as a foundation for developing innovative local-wisdom-based teaching materials to strengthen students' conceptual understanding.

Keywords: bamboo snap gun, contextual physics learning, local wisdom, traditional games, physics concepts

***Abstrak**: Konteks pembelajaran fisika di Indonesia cenderung abstrak, sehingga keterkaitan antara konsep fisika dan pengalaman sehari-hari siswa sering kurang terlihat. Penelitian ini memetakan konsep fisika dalam mekanisme permainan tradisional bedil jepret bambu sebagai sumber belajar kontekstual. Metode yang digunakan adalah deskriptif kualitatif berbasis analisis konseptual dari literatur serta data lapangan (observasi dan wawancara). Hasil analisis menunjukkan bahwa mekanisme bedil jepret bambu melibatkan konsep elastisitas (Hukum Hooke), gaya dan percepatan (Hukum Newton), usaha dan energi, impuls dan momentum, serta gerak parabola. Temuan ini mengindikasikan potensi besar bedil jepret bambu sebagai media pembelajaran fisika yang mengaitkan teori dengan konteks budaya lokal. Kesimpulannya, pemetaan konseptual ini dapat menjadi dasar pengembangan bahan ajar inovatif berbasis kearifan lokal untuk memperkuat pemahaman konseptual siswa.*

***Kata Kunci:** bedil jepret bambu, pembelajaran fisika kontekstual, kearifan lokal, permainan tradisional, konsep fisika*

INTRODUCTION

In the context of science education in Indonesia, physics instruction continues to face challenges in establishing meaningful connections between physics concepts and students' real-life experiences. This is evidenced by the prevailing tendency toward instruction focused on formula presentation and mathematical problem-solving without contextually linking these to phenomena that are familiar to students' lives. Overly theoretical instructional approaches frequently leave an abstract impression, causing students difficulty in understanding, constructing, and meaningfully applying physics concepts (Patandean et al., 2023). The integration of physics learning with the social and cultural context of the local environment has therefore become a relevant strategy for improving the meaningfulness and conceptual understanding of students (Arabiyah & Fatimah,

2023). In this context, traditional games as part of local culture hold great potential to be used as contextual physics learning media.

Traditional games are cultural activities passed down across generations that are often integrated with physical activity and social interaction (Anam et al., 2024). As a form of local wisdom, traditional games not only reflect social values but also contain scientific principles that can be systematically analysed from a physics perspective. Several prior studies have shown that traditional games have been successfully used as enrichment materials in physics learning because they contain aspects of motion, force, energy, and mechanics that are relevant to the school physics curriculum (Astuti & Bhakti, 2022). Other research on the kolecer game identified the concepts of force and energy as contextual teaching materials, but that study emphasised concept exploration without systematically mapping the relationship between the game mechanism and a structured physics model (Sholahuddin & Admoko, 2021). A study on the engklek game also demonstrated the potential for integrating the concept of rigid body equilibrium into learning, but the analysis remained limited to general identification without elaborating on the game's mechanical processes in detail (Febrianty et al., 2023). Nevertheless, not all traditional games have been comprehensively examined from a physics perspective.

The traditional bamboo snap gun (*bedil jepret bambu*) game is a traditional game that uses a bamboo tube with an air compression mechanism to generate the release of a simple projectile through increasing internal pressure when the trigger section is pressed. This mechanism implicitly involves several physics concepts—including gas pressure, Newton's laws, kinetic energy, and impulse and momentum—that are relevant to analyse in the context of contextual physics learning. Although this game phenomenologically demonstrates connections to various physics concepts, scientific studies that specifically identify and map these concepts within a systematic analytical framework remain limited in the physics education literature.

Several studies have examined physics concepts in traditional games such as gasing and kolecer, which have been analysed through the principles of mechanics and energy as sources for physics teaching materials. However, based on the literature review, the bamboo snap gun has not been widely discussed as a specific object of conceptual physics analysis (Anastasya et al., 2026). Physics education literature tends to focus on more popular games, while a dedicated physics study of the physical phenomena in the bamboo snap gun has not yet been a primary research focus. This situation presents a research opportunity for deeper scientific exploration of the physics phenomena embedded in this game.

This study is important because it has the potential to make a theoretical contribution through the systematic conceptual mapping of the physics concepts contained within the mechanism of the bamboo snap gun game, while simultaneously providing an alternative contextual and meaningful learning medium for students. By scientifically understanding the connection between traditional games and physics concepts, students are expected to strengthen their conceptual understanding through authentic experiences rooted in local culture. Similar studies have also shown that local-wisdom-based physics learning can reinforce the link between scientific knowledge and the real-life context of students (Anastasya et al., 2026). Based on the above, a systematic study is needed to identify the physics concepts embedded in the mechanism of the bamboo snap gun game.

This study therefore aims to identify and analyse the physics concepts contained within the mechanism of the bamboo snap gun traditional game through a theoretical review approach, so that a systematic conceptual map can be produced that may serve as a reference for contextual physics learning. The focus of this research is to elaborate the relationship between the physical phenomena occurring during the bamboo snap gun's interaction mechanism and the relevant physics principles that can be used as a source of contextual learning.

METHODS

This study employed a descriptive qualitative method aimed at systematically describing the physics concepts contained in the bamboo snap gun traditional game. The research focused on

a conceptual narrative analysis linking the mechanism of the bamboo snap gun traditional game to relevant physics concepts (Annasthasya et al., 2025).

The research object was the bamboo snap gun traditional game, analysed at the conceptual level. Data sources were drawn from relevant information obtained through both scientific literature and empirical data collected via field observation, informant interviews, and literature review. Data collection was carried out using triangulation techniques to ensure the triangulation and credibility of the findings, consistent with qualitative research practices commonly applied in science education studies (Rizki et al., 2022).

Data collection was conducted through a triangulation technique involving three sequential activities: field observation, interviews, and literature review. Field observation was carried out in stages by directly observing the use of the bamboo snap gun in the field, encompassing the method of constructing a simple bamboo snap gun, the loading of the projectile into the barrel, the compression mechanism (generating air pressure inside the barrel), and the release that produces the characteristic sound (Kawuryan, 2021). These observation steps focused on understanding how the bamboo snap gun game operates under real conditions as a physical system. Semi-structured interviews were conducted with children who play the bamboo snap gun game and one experienced informant, with the aim of obtaining information about the method of use, variations in form, and play experience with the bamboo snap gun (Suismanto & Latif, 2023). The literature review encompassed journal articles and physics textbooks that provided the conceptual foundation for analysing the empirical findings (Malan et al., 2025).

Data obtained from the observation, interviews, and literature review were analysed through four stages: data collection, data reduction, data presentation, and conclusion drawing. In the data collection stage, the researcher compiled information from observations of the bamboo snap gun's game mechanism, interview results, and supporting literature relevant to the game as the research object. In the data reduction stage, raw data were selected and focused on aspects that directly represent relevant information about the bamboo snap gun game as the research focus. The reduced data were then organised into descriptive narratives and conceptual diagrams to clarify relationships among the findings and facilitate the analysis process. In the final stage, conclusions were formulated that map the contextual physics concepts identified within the mechanism of the bamboo snap gun game and its potential for implementation as a relevant physics learning resource.

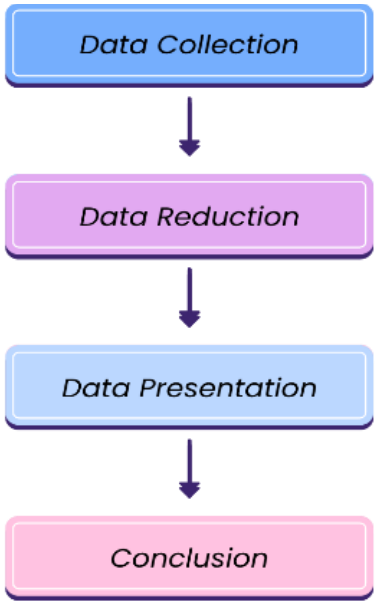

Figure 1. Stages of Descriptive Qualitative Data Analysis

RESULTS AND DISCUSSION

The Bamboo Snap Gun Traditional Game

The bamboo snap gun (*bedil jepret*) is a traditional game originating from the Sundanese culture of West Java that uses bamboo as a launcher and a simple "projectile" (fruit seeds or wet paper) (Mahyudin & Hasan, 2024). This folk game serves not only as entertainment but also reflects local wisdom and basic physics concepts (force and elasticity) passed down across generations (Ningsih & Virdyna, 2021).

Figure 2. The Bamboo Snap Gun Game (source: Traditional Games Returns)

The bamboo snap gun typically uses a dry mature bamboo stalk approximately 1–1.5 cm in diameter and 30–40 cm in length, as these dimensions provide optimal flexibility for launching a projectile up to several metres (Firiyani et al., 2025). The bamboo stalk is split and bent to store elastic energy, then pressed and released to fire the projectile. The projectiles are simple: commonly salak seeds, plumeria or water-apple flowers, rambutan seeds, or rolled wet paper. The projectile range is influenced by the tension and stiffness of the bamboo: mature, dry (flexible) bamboo tends to achieve a longer range (~4–5 metres) compared with younger bamboo (Ningtiasih, 2020).

The method of play is straightforward: the bamboo is bent downward and held, then the projectile is pushed to the far end of the bamboo barrel using a thin stick. When the bent section of bamboo is released, the stored elastic energy snaps the projectile outward—the characteristic "pletok" sound signals a successful shot (Merliza, 2021). Children typically take turns shooting at targets or simply measuring the power of their shots. This game trains motor skills and creativity (children can experiment with projectile shape or target) while also imparting practical understanding of force and elasticity in a local context (Febrianty et al., 2023).

Table 1. Variants of the Bamboo Snap Gun

Bamboo Dimensions (diam. × length)	Projectile Type	Effect on Range
~1–1.5 cm × 30–40 cm (mature/dry bamboo preferred)	Wet paper, flower petals, small seeds (e.g. salak seeds, plumeria petals)	Mature/dry bamboo is more flexible → longer range (~4–5 m) Young bamboo is stiffer → shorter range

Potential of Traditional Games as Interactive Physics Learning Resources

Traditional games are a form of local wisdom that holds educational value and can be utilised in the learning process. In physics instruction, the use of traditional games represents a contextual approach capable of connecting physics concepts with students' everyday lives. According to Fahrozy et al. (2022), a local-wisdom-based or ethnoscience approach can help students understand science concepts through the culture that exists within their community environment. In this way, physics learning is not limited to theory but also provides more authentic and meaningful learning experiences for students.

Local culture that has developed within communities can be used as a relevant learning resource in physics instruction. One such form of local culture is traditional games that have long

been known within the community. According to Asra et al. (2021), traditional games can be used as a contextual learning approach that helps students understand concepts through the culture of their surrounding environment. Furthermore, the integration of local culture into learning also serves as an effort to preserve regional culture so that it continues to be known by younger generations amid the development of the modern era.

Based on an interview conducted with a physics teacher at a senior high school in Surabaya, several pieces of information relevant to this research were obtained. The physics teacher expressed the view that the use of culture and traditional games as study material in physics learning is a very positive step because it makes learning more connected to students' lives. Traditional games such as the bamboo snap gun are considered to have a strong connection with physics concepts and can therefore serve as concrete examples in explaining instructional material. In addition, the use of local culture is also regarded as capable of introducing local wisdom values to students while preserving traditional culture within the community.

Based on the interview results, the bamboo snap gun game is known to contain various physics concepts, including work, momentum, air pressure, force, energy, and motion. The physics teacher stated that these concepts can be directly observed through the game's mechanism, making it easier for students to understand the application of physics in everyday life. Learning linked to local cultural phenomena was also regarded as more engaging than instruction focused solely on textbook theory. Students are therefore not only able to understand concepts abstractly but also to see the real relationship between physics and activities in their surrounding environment.

Furthermore, the local-wisdom-based approach was considered capable of increasing students' interest in physics. The teacher explained that students tend to be more enthusiastic when learning is connected to traditional games or cultural elements they are already familiar with. Using traditional games as a medium for exploring physics concepts can also create instruction that is more contextual, interactive, and meaningful. Student responses to this type of learning are generally more positive because they find physics material easier to understand and less difficult or tedious.

Despite these advantages, several challenges exist in applying local culture to physics instruction, including time constraints, limited supporting references, and the scarcity of media or teaching materials that integrate local culture with science concepts. Nevertheless, the physics teacher expressed the view that the local-wisdom-based approach remains relevant in the current curriculum because it helps develop innovative learning while preserving regional culture. Further development of local-culture-based physics learning is therefore needed to enable its optimal utilisation in the educational process.

Physics Concepts in the Bamboo Snap Gun Traditional Game

The bamboo snap gun traditional game is a folk game that uses bamboo as its primary component. Beyond its function as a form of entertainment, this game also contains various physics concepts that can be observed directly. Based on the observation results, the working mechanism of the bamboo snap gun demonstrates the application of the concepts of elasticity, Newton's laws, work and energy, impulse and momentum, and parabolic motion.

Table 2. Physics Concepts in the Bamboo Snap Gun Traditional Game

Physics Concept	Occurrence in Bedil Jepret Bambu	Explanation
Elasticity and Hooke's Law	When the trigger blade (bamboo spring) is pulled back	Bamboo has elastic properties. When the player pulls the trigger blade back, it stretches and stores potential energy. The further it is pulled, the greater the restoring force that acts to return the bamboo to its original position.

Newton's Laws	When the trigger is released and propels the projectile	When the bamboo blade is released, a large thrust force acts on the projectile. In accordance with Newton's Second Law, the projectile undergoes acceleration proportional to the thrust force and inversely proportional to its mass.
Work and Energy	As the projectile is launched from the bamboo barrel	An energy transformation occurs. When the blade is pulled back, the bamboo stores elastic potential energy. Upon release, this potential energy is converted into kinetic energy, propelling the projectile at high speed.
Impulse and Momentum	When the bamboo blade strikes the projectile abruptly	Contact between the bamboo striker and the projectile occurs over an extremely short time interval, generating a large impulsive force that changes the projectile's momentum from rest to rapid motion.
Parabolic Motion (Kinematics)	When the projectile exits the barrel and becomes airborne	After the projectile is launched from the bamboo barrel, it moves through the air at a specific elevation angle under the influence of Earth's gravitational force, resulting in a curved, parabolic trajectory.

Elasticity and Hooke's Law

The bamboo material used as the trigger has elastic properties, enabling it to undergo temporary deformation when a tensile force is applied. When the trigger is pulled back, the bamboo stretches and stores elastic potential energy. The greater the displacement applied, the greater the restoring force generated to return the bamboo to its original position. This phenomenon is consistent with Hooke's Law, which states that the elastic force is directly proportional to the extension of the object as long as it remains within the elastic limit. Mathematically, this relationship is expressed as follows:

$$F = -k\,\Delta x$$

The constant k represents the stiffness of the bamboo, while the negative sign indicates that the restoring force always acts in the direction opposite to the displacement. The trigger's capacity to generate a propulsive force is therefore determined by the elastic properties of the bamboo material used.

Newton's Laws

The projectile launch mechanism of the bamboo snap gun is a simple illustration of Newton's Laws in action. Before the trigger is released, the projectile is at rest, satisfying the principle of inertia described by Newton's First Law: the projectile will remain stationary until an external force acts upon it.

$$\Sigma F = 0$$

When the trigger is released, the bamboo exerts a thrust force on the projectile, causing it to accelerate and move out of the barrel. The relationship between force, mass, and acceleration is described by Newton's Second Law:

$$\Sigma F = m \cdot a$$

This equation shows that the projectile's acceleration is influenced by the magnitude of the thrust force exerted by the trigger and by the projectile's mass. The greater the force generated by the bamboo, the greater the acceleration experienced by the projectile. Conversely, a projectile with greater mass will be more difficult to accelerate.

Work and Energy Transformation

During this game, an energy transformation occurs from elastic potential energy to kinetic energy. When the trigger is pulled back, the player performs work that causes the bamboo to store elastic potential energy. The magnitude of this energy can be expressed by the following equation:

$$Ep = \frac{1}{2} k \Delta x^2$$

When the trigger is released, the elastic potential energy is converted into kinetic energy, causing the projectile to move at a certain velocity. This kinetic energy can be calculated using the equation:

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

If friction is neglected, almost all the elastic potential energy stored in the bamboo is converted into the projectile's kinetic energy. Consequently, the further the trigger is pulled back, the greater the stored energy and the faster the projectile travels upon launch.

Impulse and Momentum

When the trigger contacts the projectile, a collision occurs over an extremely short time interval, generating impulse. Impulse is the product of force and the contact time interval, expressed by the following equation:

$$I = F \Delta t$$

This impulse causes a change in the projectile's momentum. The projectile, initially at rest, moves at high velocity after receiving the force from the trigger. The relationship between impulse and the change in momentum is expressed through the following equations:

$$I = \Delta P$$
$$I = m \Delta v$$
$$I = m (v_2 - v_1)$$

The magnitude of the projectile's momentum is determined by its mass and velocity. Therefore, the greater the impulse delivered by the trigger, the greater the change in the projectile's momentum.

Kinematics of Parabolic Motion

After the projectile leaves the barrel, the thrust force from the trigger no longer acts on it, and its motion is governed by Earth's gravitational force. If the snap gun is aimed at a specific angle to the horizontal plane, the projectile's trajectory traces a parabolic curve. The initial velocity of the projectile can be resolved into two components—horizontal and vertical:

$$v_x = v_0 \cos \vartheta$$
$$v_Y = v_0 \sin \vartheta - g t$$

Motion in the horizontal direction constitutes uniform linear motion (GLB) because the velocity remains relatively constant, while vertical motion constitutes uniformly accelerated linear motion (GLBB) due to the effect of gravitational acceleration. The combination of these two types of motion produces the parabolic trajectory of the projectile.

CONCLUSION

This study successfully mapped and analysed the physics concepts involved in the mechanism of the bamboo snap gun traditional game, namely elasticity (Hooke's Law), Newton's laws, work and energy, impulse and momentum, and parabolic motion, thereby fulfilling the research objectives. These findings demonstrate that the bamboo snap gun holds significant potential as a source of contextual physics learning that links theory with students' authentic experiences and local culture. The results are consistent with prior studies concluding that the integration of traditional game ethnophysics into physics instruction can strengthen students' learning motivation and conceptual understanding. A limitation of this study is that it remains descriptive and conceptual in nature and has not yet been directly tested in a classroom learning context, meaning the effectiveness of the bamboo snap gun as a teaching medium has not yet been empirically measured. Future research is therefore recommended to develop a module or teaching material based on the bamboo snap gun, conduct classroom-based learning trials to evaluate the impact on student learning outcomes, and explore similar studies of other traditional games.

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