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## ТРАДИЦІЙНА ІНДОНЕЗІЙСЬКА ГРА «BANDHUL SADA» ПРИ ВИВЧЕННІ ПОНЯТЬ ДИНАМІКИ ОБЕРТАЛЬНОГО РУХУ НА БАЗІ КОНТЕКСТУАЛЬНОГО ПІДХОДУ

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## INDONESIAN TRADITIONAL GAME «BANDHUL SADA» IN LEARNING ROTATION DYNAMIC CONCEPTS WITH CONTEXTUAL APPROACH

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### АНОТАЦІЯ

Вчителі можуть підтримувати збереження культури, водночас забезпечуючи актуальний і цікавий спосіб викладання різноманітних предметів, залучаючи традиційні ігри в навчальний процес. Метою цього дослідження є визначення понять динаміки обертального руху через традиційну індонезійську гру «Bandhul Sada» на базі контекстного підходу.

**Формулювання проблеми.** Ми зосередилися на тому, як вивчити поняття динаміки обертального руху через традиційну індонезійську гру «Bandhul Sada». Таке визначення включає аналіз понять динаміки обертального руху в грі «Bandhul Sada» та аналіз навчальних кроків при використанні цієї гри на базі контекстного підходу.

**Матеріали і методи.** Використано якісні методи з описовим аналізом. При аналізі понять динаміки обертального руху та навчальних кроків при використанні контекстного підходу використано метод нарративного огляду. Література та спостереження були використані як методи збору даних.

**Результати.** Результати дослідження показують, що (1) у грі «Bandhul Sada» можна пояснити такі поняття динаміки обертального руху, як лінійну швидкість, кутову швидкість, крутний момент і кутовий момент; (2) цю гру можна застосувати в навчанні на базі контекстного підходу. Етапи використання цієї гри наступні формування системи знань студентів, розвиток початкових знань студентів із використанням гри «Bandhul Sada», проведенні опитування шляхом обговорення та рефлексії. З усіх цих етапів навчання виявляється, що існує зв'язок між підходами до навчання та досягненням цілей.

**Висновки.** Таким чином, можна зробити висновок, що традиційна гра «Bandhul Sada» може бути використана як реальний приклад у вивченні таких фізичних понять динаміки обертального руху, як кутова швидкість і лінійна швидкість. Це надає студентам цінний досвід побудови системи власних знань різними методами.

**КЛЮЧОВІ СЛОВА:** традиційна гра; поняття динаміки обертального руху; контекстний підхід.

### ABSTRACT

Teachers can support cultural preservation while also providing a relevant and interesting way to teaching diverse subjects by including traditional games into the learning process. The aim of this research is identify the rotation dynamic concepts of Indonesian traditional game «Bandhul Sada» with contextual approach

**Formulation of the problem.** We focused how to learn the rotational dynamic concept with traditional game «Bandhul Sada» and implementation learning steps with contextual approach. This identification includes analysis of rotation dynamic concepts in «Bandhul Sada» and analysis of learning steps with a contextual approach to the application of the game.

**Materials and methods.** The method used qualitative approach with descriptive analysis. In the analysis of rotation dynamic concepts and learning step in contextual approach, we used the method of narrative review research. Literature and observation have been used as the data collection methods. In the analysis of learning step, we used the literature review includes gathering information through literature that supports the development of learning steps based on a contextual approach.

**Results.** Result of the research shows that (1) in «Bandhul Sada» game can be explained the concept of rotation dynamics that occur, namely linear speed, angular velocity, and angular momentum; (2) this game can be applicate in learning with contextual approach. This learning consist of 5 phase. There were constructing knowledge possessed by students, developing students' initial knowledge, using game «Bandhul Sada» in delivering material concepts, conducting inquiry processes through discussion activities and finally reflection. From all these learning phases, it appears that there is a relationship between teaching approaches and achievement of goals.

**Conclusions.** Thus it can be concluded that the traditional game «Bandhul Sada» can be used as a real example in learning physics the concept of rotational dynamics such as angular velocity and linear velocity. And it provides students with valuable experience in constructing their own knowledge in a variety of methods.

**KEYWORDS:** traditional game; rotation dynamic concept; contextual approach.

### INTRODUCTION

When applied in a real-world situation, physics becomes more interesting and understandable. Educators have embraced innovative ways, such as modifying traditional games to create compelling learning experiences (Baran et al., 2018), to bridge the gap between theoretical concepts and practical knowledge. There has been an increasing acknowledgment in recent years of the significance of incorporating cultural aspects into teaching techniques (Baran et al., 2018; Hainey et al., 2016; Sholahuddin & Admoko, 2021). Teachers can support cultural preservation while also providing a relevant and interesting way to teaching diverse subjects by including traditional games into the learning process. Studies on the effectiveness using traditional games in education have produced promising results. According to studies, including traditional games in the curriculum helps raise students' involvement, motivation, and cognitive skills (Deta et al., 2021). It also supports cultural identity and plays a role in the preservation of indigenous traditions and knowledge (Kancanadana et al., 2021).

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In Indonesia, the game of Bandhul Sada has a high cultural importance and has been played for many years. Its significance as a cultural heritage that symbolizes kinship within a community and traditional values has been emphasized by academics and scholars. It is seen as a sign of unity, and incorporating it into teaching methods helps encourage cultural awareness and preservation among pupils. The advantage of this traditional game is that it may be used as a learning tool or approach. Physics is included with nature-based learning, often known as Natural Sciences. There is one feature of science learning that distinguishes it from other subjects. Students must understand the concepts contained in learning materials for themselves through diverse activities such as discussing, observing, and investigating the problems (Fatmaryanti et al., 2017, 2018). They also have to be skilled to solve problems within their immediate environment. (Fatmaryanti et al., 2020).

One of the unique physics concepts that can be found in everyday activities is the concept of rotational dynamics. Difficulties often found in students were in analyzing the concept of moment inertia, acceleration of angles, torque and the relationship with kinetic energy of rigid object rotation (Haji et al., 2015). In other research also found that student difficulties lie in the relationship of moment inertia to rotational energy, and the effect of torque on angular acceleration (Jannah & Ermawati, 2020). Mastery of basic concepts about the dynamics of rotation will affect the ability of students to master the material further.

There hasn't been much research done specifically on using "Bandhul Sada" to teach rotation dynamics principles. Studies exploring the use of traditional games in science teaching have, however, shown how successful they are at improving students' comprehension of scientific ideas (Baran et al., 2018; Putranta et al., 2021). Future research can investigate how "Bandhul Sada" can be modified to illustrate ideas like angular velocity, and rotational equilibrium. To improve students' conceptual understanding, we conduct a detailed study of innovative learning models with traditional games. We focused how to learn the rotational dynamic concept with traditional game "Bandhul Sada" and implementation learning steps with contextual approach.

## METHODS OF THE RESEARCH

The descriptive review method of research has been used in this article. Analysis of traditional games is viewed from the whole process when the game is being carried out with analysis of physics concepts and analysis of learning step.

In the analysis of rotation dynamic concepts, we used the method of narrative review research. This method is equivalent to the literature study approach as it integrates data collected from research objects collected from several literacies before coming to a conclusion. Literature and observation have been used as the data collection methods. The observation activity that was conducted used indirect observation, especially visual observation through photos and video recordings during the game. The research material was analyzed as a variation on the traditional game "Bandhul Sada", where the researcher examined the possibilities of any physics concept presented. The process of collecting data was through journal reviews. Data collected from various sources will be analyzed and adapted to the topic of physics concept analysis, namely the concept of rotational dynamics. The results of investigations from various sources are collected and integrated into a finding that can be useful for teachers and students in implementing physics learning.

In the analysis of learning step, we used the literature review includes gathering information through literature that supports the development of learning steps based on a contextual approach. Each learning step is described in detail regarding the learning activities carried out by students and teachers.

## RESULTS AND DISCUSSION OF RESEARCH

Understanding how to apply basic physics concepts can be attained by creates activities and knowledge concerning suitable applications in real life situations. Cultural traditions can be used as a learning resource, particularly in physics education, which requires physical and real-world applications that improve students in understanding.

### Analysis of Rotational dynamic concepts in "Bandhul Sada"

Bandhul sada uses items that are no longer used, namely Bluluk (coconut buds). This game can be played alone or in groups. The way to make these traditional toys is only in the form of bluluk which is given a rubber band as seen at figure 1. The way to play it is very easy, that is, you just need to rotate the bluluk around on the floor or ground, so that the rubber band that is attached is then tightly twisted. When it's twisted, lift it and float the rubber in the air, then we will see the turtledove spinning in the air until the rubber twist runs out and returns to normal. Participants in the game use a string to spin a wooden top called a "Bandhul Sada", then release it onto a playing field that has been demarcated. Players must deftly control the top's motion as it spins, offering a singular chance to investigate rotation dynamics.

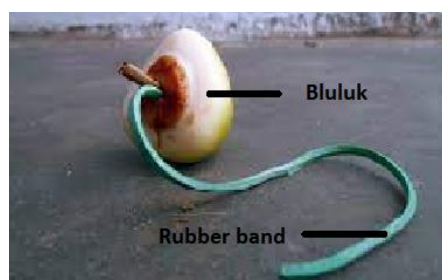




Figure 1. The Part of Bandhul Sada

From the results of the analysis of the concept of rotational dynamics found in traditional game "Bandhul Sada", it was found that the game contained several basic concepts of rotational dynamics. The concepts that can be found in the game can be seen in Table 1.

Table 1

Concepts of rotational dynamics can be found in step of “Bandhul Sada”	
Step of “Bandhul Sada”	Concept of rotational dynamics
<p><b>Step 1:</b> Rotate the rubber on the floor until it become short</p> 	<p>The concept of elasticity occurs when the rope is wrapped around the top. At that time, there was a concept of elasticity in the rubber strap and it caused the top to rotate.</p>
<p><b>Step 2:</b> lift it and observe the spin</p> 	<p>The rotational dynamics process is related to concept of angular and linear velocity. When moving, the bluluk in the Bandhul Sada game takes a changing position, namely turns. There is a change in time from the initial position to a different displacement position.</p>

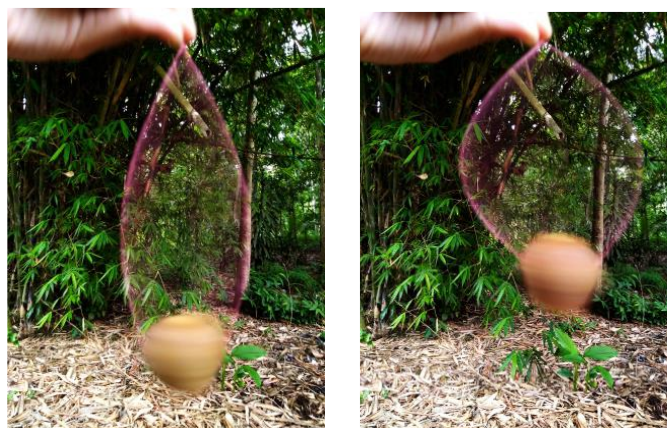


Figure 2. Difference of velocity and diameter against time

The angular displacement is the displacement encountered by the propeller during circular motion. Furthermore, when the bluluk rotates, it possesses angular velocity. The angular velocity can be calculated by taking the angular displacement traveled in a given time and dividing it by the time. As a result, it can be stated as equation 1.

$$\omega = \frac{\Delta\theta}{\Delta t} \tag{1}$$

The angular displacement taken in a period of time  $\Delta t = T$  and  $\Delta\theta = 2\pi rad$ . So, we found the angular velocity experienced by a bluluk in a regular circular motion is formulated as equation 2.

$$\omega = \frac{2\pi}{T} \tag{2}$$

The rotational dynamics process is related to angular velocity and linear velocity. When moving, the bluluk in the bandhul sada game takes a changing position, particularly turning. The time from the initial location to the displacement position is different. It can be shown that there is a time that changes from the propeller movement conditions, which can be formulated as equation 3

$$\Delta t = t_2 - t_1 \tag{3}$$

In this bandhul sada game, the d value is the length of the side of the rubber band. In terms of angular velocity ( $\omega$ ) and linear velocity ( $v$ ), it requires a value of d (diameter). So that we get the equation (4)

$$v = \left(\frac{d}{2}\right) \omega \tag{4}$$

Angular velocity is influenced by the rope force. In “Bandhul Sada”, magnitude of the force is translated as the size of the rope style when we rotate the rope on the bluluk. The greater the force we give, the greater the torque pressure which ultimately the greater the angular velocity that will be produced. Vice versa. The smaller the force we give when we rotate the bluluk rope, the smaller the speed of the angle produced. In addition to the force factor, the “Bandhul Sada” mass also affects the speed of the rotating angle. The greater the bluluk mass, the smaller the angular velocity.

### Analysis of learning steps with a contextual approach

The contextual approach to learning facilitates teachers in integrating classroom material with situations from the real world. It helps students to connect their knowledge to its application in their lives as family members and members of society. Contextual learning has given students in groups or working together the most opportunities to explore and integrate a physics problem. Phases of application “Bandhul Sada” game in learning with contextual approach can be seen in Table 2.

Table 2

Learning activities in each step of contextual approach with traditional game

Phases	Learning Activities
Constructing knowledge possessed by students	Construct the knowledge students have with material to be studied, and related to the context of everyday life
Developing students' initial knowledge	Discuss with asking about concept that student have before
Using “Bandhul Sada” game in delivering material concepts	Students play the game “Bandhul Sada” together and make observations based on the variables guided by the teacher
Conducting inquiry processes through discussion activities	Discuss the concepts of rotational dynamics from observational data on the worksheet.
Reflection	Group discussion and do some examination

In order to perform their role as active learning subjects, students play traditional games that integrate physics learning. The teacher must develop an effective plan for teaching physics using traditional long-distance games. Planning an exhaustive instructional design is part of the strategy that teacher needs to get prepared to teach when using traditional distance game-based physics learning. Learning implementation is determined by instructional design (Khalil & Elkhider, 2016). The learning objectives will probably not be achieved to their maximum potential if the instructional design is not organized and comprehensive. Additionally, the abilities of students cannot also improve in accordance with defined learning objectives (Lee & Kim, 2017).

A teacher needs to guide students to find their own concepts through their own creativity. The goal is to construct knowledge into the mind by emphasizing process over outcome (Kivunja & Kuyini, 2017; Dagar & Yadav, 2016). So, in first phase, constructing knowledge, students are invited to construct knowledge with rotational dynamics material through examples in everyday life. The teacher provides examples such as pulleys in wells, ballet dancers and so on. In second phase, developing students' initial knowledge, the teacher guides the discussion with asking about concept that student have before. In the third phase, delivering material concepts, the students make observation based on the variables guided by teacher. From these quantities they discuss the relation of quantities. The purpose of this stage is for students to be able to identify scientific principles and their relationships, control variables (distinguishing independent variables, dependent variables, and control variables), until finally students design their own experiments (Bigozzi et al., 2018). In fourth phase, conducting inquiry processes, students give analysis with began mentioning physics quantities, like rope length, time, mass etc. They discuss the concepts of rotational dynamics form observational data on the worksheet. In the last phase, reflection, students make group discussion and do some examination. The examination is carried out in the form of performance, tests or quizzes, assignments, presentations, and results of students' traditional game-making projects are used to evaluate physics learning based on traditional games.

From all these learning phases, it appears that there is a relationship between teaching approaches and achievement of goals. Student knowledge can be increased by inducing mastery goals, not performance goals (Meece, 2023). For example, by creating a constructivist learning environment with the thought that all ideas are useful, rather than asking students about their ideas but just to make corrections.

### CONCLUSIONS AND PERSPECTIVES FOR A FURTHER RESEARCH

Learning by applying traditional game with contextual approach has given authentic experience for teacher. This finding is in line with the finding that the students' understanding and problem solving skills that will increase if they have the experience to perform or train these skills.

Based on the findings of various analyses and observations, it is concluded that the traditional game Bandhul Sada has the potential for the development of rotational dynamic notions such as angular velocity and linear velocity. In this study, we concluded that there was a need for physics teachers to innovate in order to help students understand the material more easily by connecting the physics material based on local wisdom or anything related to student life in terms of this in the traditional game from West Java. Based on the research findings, the researcher proposes that each physics teacher employ another traditional game since it provides students with valuable experience in constructing their own knowledge in a variety of methods.

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