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Analysis of physics concept of newton's laws on the dadhak merak dance in the reogponorogo cultural arts

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Abstract. Indonesia is a multicultural country with a variety of cultures, one of which is Reog Ponorogo. Reog Ponorogo is a traditional dance passed down from generation to generation as a culture and identity of the Ponorogo society. Unfortunately, many people considered that Reog Ponorogo only as entertainment that does not contain scientific concepts. This research investigates physics concepts, especially Newton's Law in Dadhak Merak dance of Reog Ponorogo. This research used the content analysis method involving unitizing, sampling, recording, reducing, inferring, and narrating. The result indicated that Newton's First Law came up in the inertial frame of the Dadhak Merak. Newton's Second Law is shown in the acceleration changes influenced by the mass and force of Pembarong. Newton's Third Law is related to the dancer's reaction force and the ground that raises a lateral force to the Dadhak Merak dance. This research is expected to contribute as a source of information on the development of contextual teaching and learning physics material.

1. Introduction

Culture is a way of life that develops in a group of people or community and is passed down from generation to generation as a way of living. Culture is formed based on several elements such as religion, politics, lifestyle, architecture, works, fashions, and languages. Reog Ponorogo is classified as traditional art, and it is prevalent in East Java. Reog art can be found in around 17 districts in East Java involving Mojokerto, Kediri, Surabaya, Jombang, Pacitan, Ngawi, Nganjuk, Trenggalek, Tulungagung, Sidoarjo, and Ponorogo itself, where the Reog Ponorogo art developed [1]. The popularity of the Reog Ponorogo art in the East Java Region makes this traditional art still subsist today.

Indigenous knowledge needs to introduce to the school. Students need to be aware of Indonesian culture and preserve the cultural diversity that has become the nation's identity [2]. The introduction of culture can be conducted by integrating the indigenous culture's scientific process into school science by providing scientific rationalization on the existing indigenous knowledge. The integration of indigenous knowledge into school science is known as ethnoscience [3]. Students' everything can be used as a scientific knowledge source to build and construct their fundamental knowledge [4]. One of the subjects included in the realm of ethics is physics concepts [5]. Physics is part of natural science to explain and investigate various natural phenomena and their interactions. In daily activities, Physics studies matter more related to motion and behavior within space and time and the related actualities of an object's energy and force. Based on the description above, it is necessary to investigate the physics concept in the Reog Ponorogo to make physics learning more contextual and based on local wisdom to preserve indigenous culture. This study aims to identify the concept of Newton's Laws in the art of Reog Ponorogo, especially on the components of Dadhak Merak.



2. Method

The method used in this study was qualitative content analysis. This research was a semiotic content analysis that is usually used in cultural research by understanding the meaning. The objects of semiotic research are mass media, films, comics, cartoon literature, and music [6]. In this study, the researcher used an acceptable method, such as interviews, documents, and observation, to gather various comprehensive information. Interviews were conducted with experts and the Reog player or Pemandu to support researchers' opinions regarding the Reog Ponorogo. The document analysis sheet is based on the theoretical basis of Newton's laws. At the same time, observation is conducted carefully by analyzing the Reog Ponorogo videos and art images. The main instrument used in this study was the human instrument, namely the researcher himself with the accuracy, criticality, and knowledge of the researcher researching and searching for data [7]. The validity of the data in this study is based on the validity of semiotics. The semantic validity is implemented to determine the suitability of the analysis results' in the chosen context [8]. Experts carried out this validation by checking the suitability of the data interpreted with the actual concept. Following this research design.

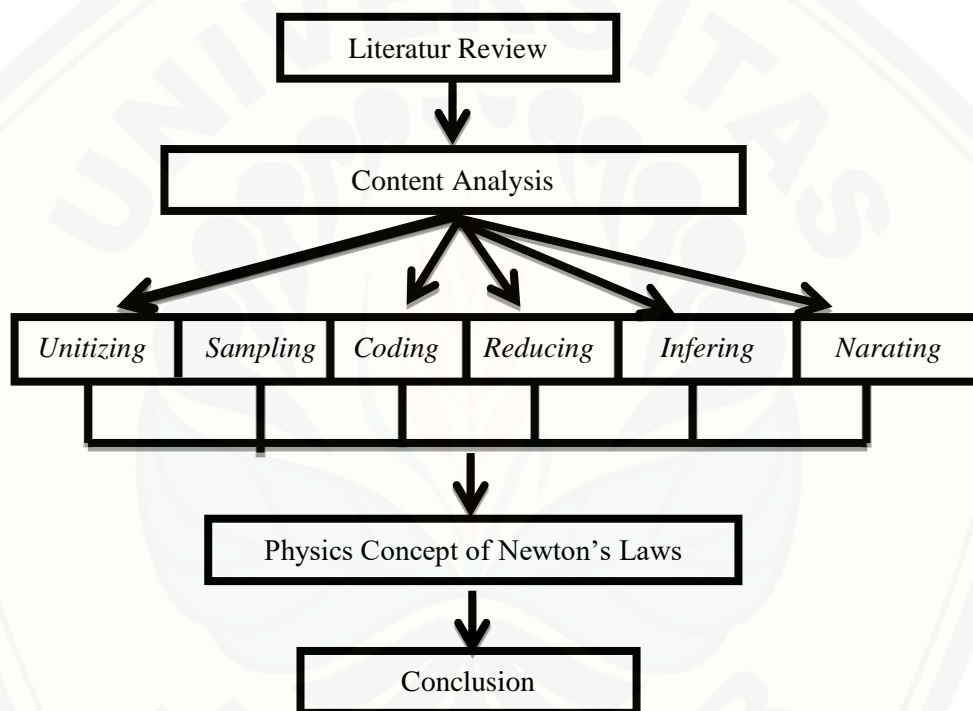


Figure 1. Research Design

The data analysis technique used in this study, According to Krippendorff, 2004 follows six stages as follows: (1) unitizing in this stage the researcher collects data relating to research that is calm Reog Ponorogo art, (2) sampling this stage was done to facilitate research, the data entered only data relating to Dhadak peacock Reog Ponorogo. (3) The recording was done with the findings on the Reog Ponorogo video or image. (4) 'Reducing was done to eliminate things that are not relevant to the study. (5) Infering (conclusion drawing) was done by analyzing the data further by searching for existing units' meaning. (6) Narrating this stage was decision making based on research results—some text.

3. Result

This study analyzed the physics concepts that exist in Reog Ponorogo of Dadhak Merak dance. The result of the data analyzed in the interviews is presented in the following table.

Table 1. Interviews results concerning Newton's 1st Laws

Researcher	<i>Nari damel topeng dadhak merak punapa butuh tenaga ingkang roso?</i>	Is It require much energy when dancing using dadhak Merak?
Informants	<i>Iyo butuh tenaga seng kuat</i>	Yes, it needs more substantial energy when using the Dadhak Merak mask

Table 2. Interviews results concerning Newton's 2nd Laws

Researcher	<i>Menawi tarian gerakanipun cepet, punapa tenaga ingkang dibutuhaken luweh kathah?</i>	If the dance uses fast movements, will the energy require also be greater?
informants	<i>Iyo, luweh cepet kesel</i>	Yes, it gets tired more easily
Researcher	<i>Menawi wonten penonton ingkang nunggangi Dadhak merak punapa krasa luweh abot?</i>	If there are people who rise above the Dhadak Merak, will it be more decadent?
Informants	<i>Iyo pomo enek seng numpak Dadhak merak iku soyo abot, soal e pomo maune abot e 50 kg iso dobel dadi gak iso suwi-suwi mergakne yo soyo cepet kesel</i>	If there are people who rise above the Dhadak Merak it will be heavier because the initial weight (Dhadak Merak) 50 Kg can be doubled, so the movement is not long because it is easier to be tired.

Table 3. Interviews results concerning Newton's 3rd Laws

Researcher	<i>Menawi muter e ngiwo kaknipun dijorokake nengen nggeh?</i>	When rotating to the left, does the foot press to the right?
informants	<i>Iyo, arah e sikil walikane</i>	Yes, the direction is the opposite

Informants said that performing Dhadak Merak requires energy or a trainer to give a force to move Dadhak Merak. According to the informants, a style was given shortly after performing the Kebat movement, which makes Dhadak Merak move beautifully after Pembarong stood up. This is showing that Newton's First Law came up in the inertial frame of the Dadhak Merak. The faster the movements made by the Pembarong, the easier the Pembarong will feel tired. If the mass of Dhadak Merak increases due to the presence of someone riding on top of Dadhak Merak, then what Pembarong feels will be heavier, because the burden carried is getting heavier, so doing this movement is usually not too long. This proves the Newton's Second Law is demonstrated in the changes of acceleration in dance influenced by the mass and force of Pembarong. When the Pembarong makes a circular motion to the left, then his feet will press the ground to the right. Then his feet will press the ground to the right. This shows the existence of Newton's third Laws

4. Discussion

The Dadhak Merak dance starts with the performer wearing a mask that has the shape of a lion's head completed with a crown made of peacock feathers. This mask has a mass more than 50 kg. This heavy mask will be carried by dancers using teeth [9]. The movement on the Reog dance using the Dhadhak Merak is not something that is easily needed by its thoughts to regenerate because the scene cannot be

played by just anyone [10]. Dadhak Merak dance is inseparable from the concept of physics, one of which is Newton's law. Newton's Law provides explanations related to the position's, speed, acceleration, and time [11].

4.1 Newton's First Law

Newton's first law states that the resultant force acting on the Dadhak Merak is zero. In this movement shows the application of Newton's 1st Law: if the object is stationary, then the object will remain stationary [12]. Based on the recognition from the guest speaker named Supriyono as follows

"In using the Dadhak Merak mask, it requires stronger energy." (07/25/2020).

Dadhak Merak moves due to the force performed by the dancer. As shown in Figure 2 below



Figure 2. Kebate dance

When the dancer or performer performs Kebate dance or movement results in the Dhadhak Merak mask by bending the body backward so that the Dhadhak Merak touches the floor with the foot of both feet. After a while, the Dhadhak Merak is pulled back up so it looks Dhadhak Merak as if moving beautifully and supply. This shows the strength, flexibility, and balance of the Pekarongan body. This movement shows the application of Newton's first Law in which the Dhadhak Merak, which was originally standing still when given a backward force quickly it will be seen at the top of the Dhadhak Merak maintains its state. The situation is proof of the nature of inertia. Newton's 1st Law is often called the law of inertia [13].

4.2 Newton's Second Law

In the Reog Ponorogo dance, the dancer moves with certain speeds according to the tempo of the musical accompaniment. So that the dancer/performer moves with an uncertain speed. This change in speed results in an acceleration/deceleration of movement. When a dancer or performer wants to make a quick move, a great style is needed. This is in accordance with Newton's 2nd Law, namely, "The acceleration of an object is directly proportional to the total force acting on it and inversely proportional to its mass. The direction of acceleration is the same as the direction of the total force acting on it" [14]. Mathematically written

$$a = \frac{\sum F}{m}$$

Where the force that works is directly proportional to the magnitude of speed. So when the Pekarongan wants to make movements quickly Pekarongan must provide a great force so that the Dhadhak Merak moves in accordance with the wishes of the Pekarongan. Additionally, the magnitude the force given by the Pekarongan to make movements is influenced by the mass of the Dhadhak Merak. In the Reog Ponorogo dance performance, there are not infrequently scenes wherein someone is riding a Dadhak Merak.



Figure 3. Someone rides dadhak merak

Based on Figure 2 the mass received by the Pembrang certainly increased not only the Dhadhak peacock mass, but also the mass of the person. Accordance with Newton's Second Law, where mass and force are directly proportional when the mass plus the force required will be even greater. Addition, there are several forces in the opposite direction to the forces carried out by the Pembrang namely the force of gravity and air friction. Therefore, from that in one show usually provided 2-3 Barongan players who will play the dance alternately so as not to fatigue.

4.3 Newton's Third Law

In the Reog dance, there is also a movement to shake the Dhadak Merak by moving forward and simultaneously rotating the body from right to left. Every movement, such as to wag Barongan there are rules about the position of the feet, neck and hand movements according to Supriyono

"The position of the foot is one step forward, with the neck shortened. While both hands are used to shake the peacock's Dadhak ..." (04/18/2020)

"When making a circular motion must balance the legs and pressed" (07/25/2020)

According to Newton's Third Law "When an object exerts a force on both objects, the second object exerts an equal force, but in opposite directions to the first object" [15].



Figure 4. Force action reaction of the foot and ground

When the Pembrang makes a circular motion to the right, then his feet will press the ground to the left. The ground will react and press the spacer to move right so the trajectory moves to the left. Vice versa if you want to make a circular motion to the left, then his feet will press the ground to the right.

This shows the existence of Newton's 3 Laws that "for every action, there is an equal but opposite direction" reaction. Mathematically written as follows:

$$\sum F_{action} = \sum F_{reaction}$$

The action force is the compressive force performed by the dancer / Pembarong against the ground. So that the ground will give a reaction force so that the dancer / Pembarong moves in the opposite direction.

5. Conclusion

The dance in the Reog Ponorogo art can give an actual picture related to the application of Newton's Law to explain the acceleration relationship of the Dadhak Merak with the style that works on the Dadhak Merak. Newton's first law explains the inert nature of Dadhak's Merak in the Kebat movement. Newton's Second Law explains changes in acceleration or deceleration in dance as well as the influence of the mass of the style issued by the Pembarong. While Newton's third Law relates to the reaction force of the dancer and the ground to give a sideways force on the Dadhak Merak. Reog Ponorogo still has many other movements that need to be studied scientifically. So, further research is needed to examine other concepts in Reog Ponorogo art as a source of information in the development of contextual physics learning

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