Bringing Javanesse Traditional Dance into Basic Physics Class: Exemplifying Projectile Motion through Video Analysis

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Abstract. An alternative approach of an arts-based instruction for Basic Physics class has been developed through the implementation of video analysis of a Javanesse traditional dance: Bambangan Cakil. A particular movement of the dance -weapon throwing- was analyzed by employing the LoggerPro software package to exemplify projectile motion. The results of analysis indicated that the movement of the thrown weapon in Bambangan Cakil dance provides some helping explanations of several physics concepts of projectile motion: object’s path, velocity, and acceleration, in a form of picture, graph and also table. Such kind of weapon path and velocity can be shown via a picture or graph, while such concepts of decreasing velocity in y direction (weapon moving downward and upward) due to acceleration $g$ can be represented through the use of a table. It was concluded that in a Javanesse traditional dance there are many physics concepts which can be explored. The study recommends to bring the traditional dance into a science class which will enable students to get more understanding of both physics concepts and Indonesia cultural heritage.

1. Introduction
Universitas Negeri Semarang (UNNES) has been declared as a conservation university in 2010. The internalization of conservation values in the academic field have been implemented in several activities, including the determination of the use of competency-based curriculum and conservation (KBKK), as referred to Book 1-4 of UNNES KBKK document, in any study program. With this establishment, the supporting curriculum subjects must contain learning materials that lead to the achievement of learning (learning outcomes) of students who reflect the implementation of the working curriculum.

As one of the pillars, the conservation of culture including arts is pursued through the development, appreciation, and the exploration of various aspects of the diversity of Indonesian culture to reinforce the attitudes and behavior of every citizen in UNNES and values, which is becoming a reference for all courses in the department of physics is to appreciate cultural diversity, views, beliefs, and religion and opinion / original findings of others. In line with this, there is a need, then, to integrate the study of physics and the conservation effort, which in turn is expected to grow respect to the values.

Basic Physics is a compulsory subject for first-year students in all departments in the FMIPA, UNNES, with motion as one of the learnt topic. The problem that arises is that the daily life examples commonly used for explaining this topic never touch the Indonesian traditional dance. Several physics textbooks used as learning sources, even, only provide examples of motion topics by using non-
Indonesian dance movements [1,2]. In fact, the Indonesian dances have many beautiful movements which, of course, relate to many physics concepts, such as motion, and can be implemented to support science learning.

Art is a humans’ made integrative element binding and unifying three general components: intellectual, symbolic and sensual [3]. Several studies have proved that the arts play an important role in science learning enabling students to have hands-on and minds-on activities in a practical work [4,5,6,7,8] through the use of several arts-work: drama, music, dance, comic and others [9,10,11,4,5]. In the learning process, the arts are used by science teacher to communicate science dealing with product and process. As the similarities owned by the art and science in several aspects [3], the idea behind the usage of the arts lies on the understanding that the emergence of creativity and critical thinking - the specific goals of science learning - is also supported by the arts. The Indonesian, particularly Javanesse, traditional dances, however, are rarely reported as the arts-work used for gaining any science class goals.

Dance movement analysis have been discussed by several studies. One of them was modelling the expressive movement of gesture in the process of interactive communication in ballet [12]. Furthermore, a variety of software that can be used to analyze dance has also been reviewed [13]. In addition, an analysis of the difference between classical ballet and contemporary dance has been carried out [14]. These all studies took the advantage of the use of a computer to support an efficient analysing process of dance movement aspects.

In trying to support the program of culture conservation in UNNES, a study of an Indonesian dance was accomplished. The study aimed to enrich Basic Physics learning process by bringing a Javanesse traditional dance into Basic Physics class to provide an interesting learning material example through the dance movement video analysis. The process and result of the analysis of the Bambangan Cakil dance movement: weapon throwing is discussed in this paper.

2. Method

2.1. The Bambangan Cakil Dance

In this study, the analysis of weapon throwing movement in Bambangan Cakil dance was carried out by using a video analyser, called LoggerPro. The Bambangan Cakil was choosen as it is a very popular and attractive Javanese dance. There are two dancers: the Arjuna depicting the good knight and the Cakil representing a bad giant. In this performance, basically, the giant and the knight are in a war where the giant is finally killed due to the knight’s weapon thrown directed to him (figure 1).

![Figure 1. Two dancers: the Arjuna and the Cakil in the Bambangan Cakil dance.](image)

2.2. Video Analysis Process

The video analysis process implemented a series of stages. Firstly, the dance video was prepared. It was followed, then, by doing provided analysis procedures ranging from setting a scale, setting the origin and coordinate system, selecting data points, making graph and curve fitting. Having all of the
procedure, several outputs can be derived, such as picture, graph and also table representing the results of the dance video analysis. These outputs were, then, explored to exemplify explanation of projectile motion.

3. Results and Discussion
The outputs resulted from the video analysis of weapon throwing movement of Bambangan Cakil dance can be used to explore several concepts of projectile motion. The first output resulted from video analysis is a picture of weapon motion path, as shown in figure 2. This picture supports the explanation of a concept of projectile motion itself. An object is said to have a projectile motion if the object moves through a curve path, namely parabola. This path picture occurred as a result of selecting data points stage. In this stage, the weapon motion was traced by putting dots at its passed path resulting its trajectory. From the picture, it can be seen that the weapon moves through a projectile path. This means that the weapon moving from its initial position, at the knight’s hand, towards the giant Cakil possesses a projectile motion. It is understandable since the weapon made a particular angle with the horizontal axis when it left the knight’s hand.

![Figure 2. Picture of weapon motion path.](image)

The next concept can be learnt from the outputs is that projectile motion is a two-dimensional motion, a superposition of two motions, with constant acceleration. In the x direction its acceleration is zero, while in the y direction, its acceleration $a_y = -g$. This concept is exemplified by the table output. The table was performed by doing auto arrange of page to see all outputs at once on the page: picture, table and graph. As shown in figure 3, the resulted table contains several data including weapon acceleration.

![Figure 3. The table resulted from Bambangan Cakil dance video analysis process.](image)
The data of acceleration shows a constant negative value. This portrays that there was a constant acceleration of the weapon in the y direction when it left the dancer’s hand. Beside the acceleration, the table also represents weapon position, that is every weapon’s X and Y position when passing through the path. It also gives data of time when the weapon lies at a particular position with a certain velocity. All of these data types are available in the table under appropriate table column heading which can be made during the analysis process. Additionally, such concepts of decreasing velocity in the y direction (weapon moving downward and upward) due to acceleration g can also be depicted through the use of the table.

An additional output yielded from the analysis is a graph (figure 4). This graph appears simultaneously with the table when the page-auto arrange icon is clicked. It displays other concept of projectile motion involved in the weapon motion: the two-dimensional motion. This concept can be explained by showing the slope of a particular point in the graph. Pointing the cursor at a particular point and then clicking the icon of tangent will generate a line representing slope at that point. This slope indicates the velocity of the object. Furthermore, the slope also represents a resultant vector of velocity showing that the x component of the velocity is the velocity in horisontal direction, \( v_x \), and the y component is the one in vertical direction, \( v_y \). Finally, the all data displayed on the picture and available in both table and graph can be used as an aid to proof equations involved in the projectile motion.

![Figure 4. Graph of parabolic weapon motion.](image)

### 4. Conclusion

Javanesse traditional dance, \textit{Bambangan Cakil}, and projectile motion are two names belong exactly to two different fields, but they, in fact, have a closed relationship. They have same unique nature. The dance consists of several beautiful movements, one of them is weapon throwing, which owns some characteristics of projectile motion. Through the use of video analysis process implementing the \textit{LoggerPro} software package, this interesting Indonesian dance provides different angle of presenting examples of object’s path, velocity, and acceleration concepts of projectile motion. The picture, table and also graph displayed empowers the science learning process through implementation of the arts-based instruction. Considering the important value behind the dance in both supporting science learning and conserving the Indonesian national heritage, it is suggested to bring it into Basic Physics class.

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