Ethnomathematics in Balinese Traditional Dance: A Study of Angles in Hand Gestures

R Radiusman\(^1\), K S K Wardani\(^1\)\(^*,\) R A Apsari\(^2\), I Nurmaawanti\(^1\), G Gunawan\(^3\)

\(^1\) Primary School Teacher Education Study Program, Universitas Mataram, Mataram, Indonesia
\(^2\) Mathematics Education Study Program, Universitas Mataram, Mataram, Indonesia
\(^3\) Physics Education Study Program, Universitas Mataram, Mataram, Indonesia

\(^*\) Email: srikusumawardani@unram.ac.id

Abstract. The study was aimed to explore the ethnomathematics in hand gestures of Balinese traditional dances. The scope of ethnomathematics discussed was limited to the geometry object, specifically angles. The object of the study was Pendet Dance, one of the popular traditional dance from Bali which usually perform to welcome the guest in a formal and informal event. The method of the research was a case study in which we deeply analyse the hand gestures in Pendet Dance. The data were gathered from observation of the dance and interview the experts in Balinese Dance. The data were analysed qualitatively using descriptive method. From the analysis, it was found that the hand gestures of the dancers in Pendet Dance is forming three types of angles, i.e. acute angle \(0^\circ < \alpha < 90^\circ\), right angle \(\alpha = 90^\circ\) and obtuse angle \(90^\circ < \alpha < 180^\circ\). The angles can be seen in a number of pattern of the hand gestures such as in ngumbang, agem, ulap-ulap and ngelung movement.

Keywords: Ethnomathematics, Balinese Traditional Dance, Angles in Hand Gestures

1. Introduction

Ethnomathematics is the combination of mathematics and cultural practices [1]. Therefore, it is closely related to the daily activities on the society [2]. As the product of mathematical concept embodied in culture, ethnomathematics is the result of human’s information processing [3] in many aspects in life. The examples of ethnomathematics can be seen in architecture [4], puzzles and games [5], counting technique [6] and traditional calendar [7]. In recent years, ethnomathematics attracts the attention of the researcher in mathematics field since it gives space for the elaboration of the existence of mathematics in non-mathematician social groups [8].

Indonesia as a country with various cultures, such as the art in building, dancing and traditional pattern; provides a number of interesting topics to be discussed in ethnomathematics. Some of the prior studies of ethnomathematics in Indonesia is the exploration of Javanese batik pattern [9], traditional practices in Central Java [2], traditional farming method [3], marble craft of Tulungagung [10] and the indigenous concepts of three-dimensional shapes in Kampung Naga [11].

From all studies in Indonesia, very few were discussing the ethnomathematics of dancing. Dance is the soul expression of the human through the rhythmical and beautiful movement [12]. The fascination of dance is based on its wiraga, wirama, and wirasa [13]. Wiraga is the skill on dancing, including: doing basic movement and remembering the sequences. Wirama is the harmony between the dance’ movement and the rhythm of the background music. Last, wirasa is the appropriateness of the expression of the dancers in term of the theme of the dance.

One of the region in Indonesia which is famous to have a rich types of dancing is Bali. Traditional dances of Bali have the standardized basic rules, consists of agem, tandang, and tangkep [12]. The basic rules regulates how the dancers should stay on particular movement, how to shift from one movement to another and what is the best expression to represent the aim of the movement. For Balinese citizen,
dancing is a part of the daily live which usually be used for the purposes of entertainments, welcoming guests and religion ceremonies. Even though it mostly used for the social practices, if we carefully studied, we can find the hidden values of the dance in the mathematical point of view. For example, there is a study about the geometry aspects of the dance, especially in lines and two-dimensional shapes [14].

Reflect to the lack of the studies that focused on the ethnomathematics in dancing, in this study we provided new point of view on the topic. The uniqueness of geometry objects in dance movement can be observed in the angles constructed by the body parts, especially hands and legs. Hence, the present study attempt to answer the research question of what kind of angles constructed in the hand gesture of the Balinese traditional dance?

In this study, we focused on Pendet Dance, one of the Balinese traditional dances, which usually be used to welcome guest in a formal and non-formal events in Bali. Pendet Dance is performed in a group of female dancers with no restricted ages. It consists of several type of standard movements, i.e. tapak sirang pada, ngumbang, agem, agem kanan, agem kiri, ngegol, ngelung, ngeseh, luk nerudut, ngumbang luk penyalin, sembah, ulap-ulap, and sekar ura. Each of the movement has specific rules for the position of hands, legs, eyes, bottom, head and other part of body.

2. Methods

This is a qualitative research with case study approach. It means, we observed the human’s activity in certain place by using the daily term on the area [15]. In this study, we thoroughly observe the movement of Balinese traditional dance called Pendet Dance which respect to the construction of geometry objects, especially angles. The data were gathered from interview with dancing teachers and observation of the dancing movement.

The dancing teachers interviewed in the study were two people (a 56 years old man and a 26 year old woman) who are the dancing’s teachers of Universitas Mataram, Mataram-NTB, and Dancing Foundation of Pradnya Sunari, Pandak Gede Village, Kediri-Tabanan, Bali, respectively. The interview questions were adjusted based on the required data of the study.

Furthermore, the observation were done by observing each movement of the hand gesture of the dancers of Pendet Dance. To enhance the validity and reliability, we used the complete video of Pendet Dance and took the step by step photos of each movement. We selected some movement which has clear image of the geometry objects’ construction. Then, we analyse it qualitatively using descriptive method. To ensure the interpretation of the researchers, we applied data triangulation by confirming the observation result from photo and video with the clarification from the experts of Balinese traditional dances.

3. Results and Discussion

Balinese traditional dances have basic standardize movement pattern which is essentially important to keep all of the body’s parts harmonious. However, due to the limitation of the study, this paper will only discuss the hand gestures. We will identify the hand gestures of the dancers of Pendet Dance and analyze it based on the types of angle in geometry.

Mathematically speaking, angle is constructed by the [16]. According to its size, angle can be classified into five types, including acute, right, obtuse, straight and reflective [17]. The present study only discuss three of those, which are acute, right and obtuse angles which are formed from the hand gestures of the dancers while doing the movement of ngumbang, agem, ngelung and ulap-ulap.

3.1 Acute Angle in Hand Gesture of Ngumbang

Ngumbang is the opening movement in Pendet Dance. It is performed by a fast walking with both of the hands hold bokor, the property of Pandet Dance as a place to keep the flowers. Bokor is put near to the heart center of the dancer. The walking pattern is start from the right to left legs with 5 × 8 counting. To get a correct ngumbang position, the elbow of the right hand should be parallel to the chest and the lower arm of the left hand is close, but not stick to, the chest (see Figure 1).
Mathematically, we can represent the position of the right elbow \((O)\) and the chest of the dancer as two points. A line, \(x\), can be drawn from those points. Suppose that we can draw another line which is perpendicular to the origin point of \(O\). The distance of the lower right arm and the chest is as big as one fist. Meanwhile, from the left lower arm we can draw another line called \(y\).

![Figure 1. Analysis of Angle in Hand Gesture of Ngumbang](image1)

From Figure 1 it can be observed that the distance between the points from lower arms, elbow and the chest of the dancers is less than \(90^\circ\). In other words, the gesture hands of \(ngumbang\) is formed the acute angle.

### 3.2 Right-angle in Hand Gesture of Agem

\(Agem\) is a basic movement which is performed in stationer position. It can be distinguished into two, left and right \(agem\). Left \(agem\) is performed by placing the right sole in front of the left sole with distance of one fist. Both soles are in the corner position, bend the knees down, push buttocks to the right side, tiptoe the fingers of the feet, bend the chest to the front and head fall to the left side. The left has is parallel to the eyes while the right had parallel to the chest. The palm of the left hand is face forward while the right hand bring the \(bokor\). The similar, but in different direction of the left-hand of every parts of body, is applied for the right \(agem\).

To help illustrating the case, this paper will only discuss about left \(agem\). In left \(agem\), the position of left elbow is parallel to the eyes of the dancers, while the upper left arm is parallel to the shoulder (see Figure 2). Suppose we draw a point each on the elbow, eyes and lower left arm, centered in elbow called \(O\). Draw a line from elbow to left eye, called \(x\), and from elbow to lower left arm, called \(y\).

![Figure 2. Analysis of Angle in Hand Gesture of Agem](image2)

From Figure 2, it can be observed that based on the position of the line drawn from the elbow to the eye and the line drawn from the elbow to lower left arm is constructed the angle of \(90^\circ\). Hence, in \(agem\) position, the hand gestures is performed right angle.

### 3.3 Obtuse-angle in Hand Gesture of Ngelung

\(Ngelung\) is the movement in which the dancers’ left hand is straight to the side and bend inside started from the palm of the hand. Meanwhile, the right hand brings \(bokor\) with elbow directed to the front side. Raise the right tiptoe and make a tremble movement on the lower leg. Direct the bottom to the right and head fall to the left.
In *ngelung* movement, the right shoulder of the dancer parallel to the elbow, while the lower arm straight to the front side, as can be seen in Figure 3. If the shoulder and the elbow of the dancer is denoted as points, a line passing these points can be drawn. Mathematically, the line can be called as $x$. In this movement, the elbow is the coordinate central point called $O$. We can draw a line, called $y$, from $O$ to the end of lower arm.

From Figure 3, it can be seen that the position of the lower arm of the dancer form an angle. The size of the angle is between $90^\circ$ and $180^\circ$ ($90^\circ < \alpha < 180^\circ$). Therefore, the rotation of the lower arm of the dancers from its origin to the end is more than 90 degrees but less than 180 degrees. ($90^\circ < \alpha < 180^\circ$). It means, the *ngelung* movement construct the obtuse angle.

### 3.4 Obtuse and Right-angles in Hand Gesture of *Ulap-ulap*

*Ulap-ulap* in daily life means to whip. It is a part of the respectful greeting of the Pendet Dance. The movement is done with sit position. The thumb bend inside while other fingers up, the wrist bend outside and parallel to the forehead. *Ulap-ulap* can be distinguished as left and right *ulap-ulap*. The left *ulap-ulap* is done by set the right hand to the shoulder and the right elbow parallel to the chest, while the left hand parallel to the head and the left elbow parallel to the left eye (see Figure 4). The right *ulap-ulap* followed the similar principal by changing the left-hand position.

In *ulap-ulap*, the center of the movement is the elbow. Represent the elbow and the right shoulder with points and draw a line, called $x$, connected those points. Then, represent the lower arm by a dot and connect it with the dot in the elbow. Draw the line that connecting those points, called with $y$. From the interview with experts, it is clarified that the position of the lower arm is right in front of the elbow.

From Figure 4, it can be seen that the elbow and the end of the left hand is perpendicular to the line passing the elbow and shoulder of the dancer. It means, they construct a $90^\circ$ angle.

Now consider the position of the left hand in *ulap-ulap*. In left hand, the centre of the hand gesture is also the elbow, we represent it as $O$. Then, the left hand is parallel to the forehead and the elbow is parallel to the left eye. If the position of the left elbow and the left eye be represented as points, we can
draw a line connecting those points called x. Then, we can draw a perpendicular line to the x called y. If the end of the lower left arm is denoted by a point called A and a line connecting O to A we will get $\overline{OA}$ as showed in Figure 5.

![Figure 5. Analysis of Angle in Left Hand Gesture of Ulap-ulap](image)

Based on the observation and interview with the experts, the line $\overline{OA}$ is not parallel to y and it goes close to x in contra-direction. It means, the measure of the constructed angle is more than $90^\circ$ but less than $180^\circ$ ($90^\circ < \alpha < 180^\circ$). Hence, the left hand in ulap-ulap forming the obtuse angle.

4. Conclusion

From the discussion, it can be concluded that the hand gestures of the Pendet Dance can be categorized in three type of angles which are acute angle ($0^\circ < \alpha < 90^\circ$), right angle ($\alpha = 90^\circ$) and obtuse angle ($90^\circ < \alpha < 180^\circ$). The acute angle can be seen in ngumbang movement, while the right angle can be seen in agem and ulap-ulap movements and the obtuse angle can be seen in the ngelung and ulap-ulap movements. The angle construction is performed by the gestures of elbow, upper and lower arm, and their position towards another parts of body such as chest and eyes. This interesting facts can be employed as a recommendation to introduce the geometry objects for elementary and secondary schools’ students. Hence, the students can learn mathematics from their culture and environment that will be helpful to increase their mathematical appreciation in daily life.

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