OPEN ACCESS

Global Journal of Research in Humanities & Cultural Studies
ISSN: 2583-2670 (Online)
Volume 03| Issue 01 | Jan-Feb | 2023
Journal homepage: https://gjrpublication.com/gjrhcs/

Original Research Article

Mathematics and Barathanatyam

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DOI: 10.5281/zenodo.7700028 **Submission Date:** 15 Feb. 2023 | **Published Date:** 28 Feb. 2023

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Abstract

Mathematics is the Science and the study of quality, structure, space and change. It is an area of knowledge that includes the topics of number, formulas and related structures, shapes, logic quality and arrangements. Mathematic skill is a skill which deals with number sense , special sense , measurement sense, Estimation sense , Pattern sense ,Problem solving sense and so on . The quality of stability, equilibrium, Repose and Perfect Symmetry are essential in Indian Arts particularly Dance, Painting and Sculpture. Geometrical formations like circle , square , Triangles, straight lines , angles, shape , size ,relative position and perfect symmetry are very essential in these Indian arts ,which are highly mathematical aspects.. Dance geometry and numbers have a fascinating relationship. Distinguished poses like straight line pattern, circular patterns and symmetry in posture development are all important features of dance. Like in Geometry certain poses provide a lovely symmetry that adds tidy elegance and greatness to the performance. Angasudhi in Dance is the result of a combination of proper posture, balance centered symmetry. In Araimandai the body is split into a sequence of triangles. The angle plays an important role for Abinaya, Adavu, Stage lighting, Dance Drama and so on.

Keywords: Angles, Adavus, Abinaya, Center Point, Numbers, Symmetry, Araimandi

INTRODUCTION

Bhrathanatyam and Mathematical Shapes

In Geometry a figure which is formed by rays and lines that shares a common end point is called an Angle. The two lines are called the sides of the angle and the common end point is called vertex. The types of angles used are acute angle, Obtuse angle and Right angle .Obtuse angle measures more than 90 degree. Acute angle measures less than 90 degree. Right angle measures perfect 90 degree. Baratanatyam is an orchestrated body movement that are synchronized to carnatic music. The various geometrical shapes that are formed are All angles , line segment (horizontal line , straight line , vertical line ,diagonal line, parallel lines) all shapes like Triangle , Rectangle , Square, Diamond shape, Semi circle , Full circle and so on.

Angles in Bhrathanatyam

To relate Araimandi with geometry the legs form diamond shape and that hands joined together to say namasthe form an isosceles triangle which can help the students to grasp different shapes much easier more than when it is just a theory on a piece of paper. In Baratanatyam each and every step, every muscle movements and the change facial expressions to another is all controlled mathematically. Dancers observes the angles of the body, legs and arms in positions such as holding a leg in the air at 90 degree angle .In dance while dancing our feet being in parallel and moving in diagonal .

In bharathanatyam angles are the important factors while doing any of the adavu. If angle is missed, the total body balance is missed. Evan while lifting a leg to take a pose, the dancer has to make sure to lift in a certain angle. Araimandi is the basic posture and to sit in Araimandi the foot should be placed in proper angle although the angle may vary

from person to person, when kept in that angle the dancer will be able to sit for a longer period and will also feel very comfortable to dance. Swasthika is a posture where one leg is placed behind the other pressing the balls of the leg. This is another posture where angle plays an important role and when missed the dancer will fall. The angle that needs to be maintained is 60 degrees that is both the knees should be diagonal. The leg placed back should face the direction opposite to the bent knee.

Adavu and Angle

While doing Năttadavu , the leg should be stretched in sides when stretching the legs it should be made sure that they are not stretched 180 degrees otherwise the body will miss balance. The other leg should maintain the half sitting help the body to maintain balance.Angles and body balance go hand in hand. Analyzing the dancer's body structure and maintaining the angle is one of the most important factors for a dancer. Just by noticing the angles maintained by dancer it can be said they are well trained.

Abinaya and Angle

In a dance drama the dancer have conversations with someone on the stage. While doing this the dancer needs special angle sense. If the dancer faces completely to the other person then the audience will not be able to see the abinaya (expression) of the dancer and if the dancer faces completely towards the audience it becomes difficult to comprehend to whom the dancer is addressing . So maintaining a particular angle is very important.

Lighting and Angle

When it comes to the light setting again angle matters a lot. The light is placed in a particular angle and most of the time the dancer has to reach that spot light and continue to dance. To do this first dancer has to calculate the angle in which they have to move and the speed in which they have to reach the spot light correctly. So the angle again plays an important role for a dance drama.

Abinaya and Mathematics

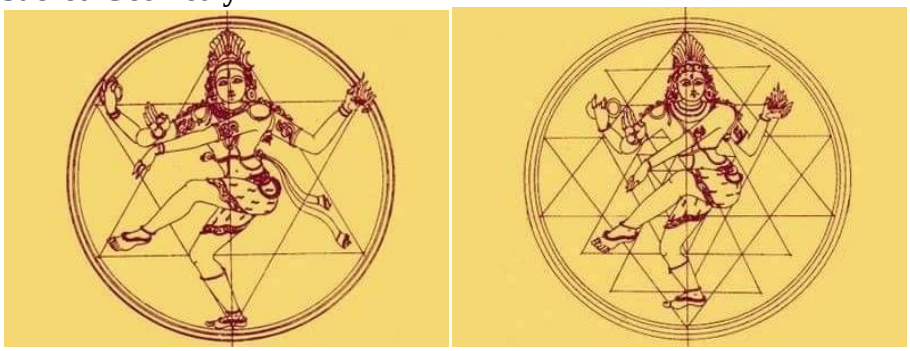
Abinaya is nothing but a Mathematics The perfection of abinaya depends up on mathematical expression of the dancer. Maths plays a crucial role in Abinaya. If mathematics is not maintained not only does the beauty of the step is lost but also the perfection. The perfection cannot be maintained while keeping the hands in Natyarambam, the hands should be stretched on two sides of the body and should be in shoulder level not below or not above. Stretched hands should be in a straight line which comes under Mathematics. Then performing each step also has mathematics. While doingparaval adavu the dancer has to make sure the hands and legs are in sync. Only in particular angle this can be possible. When doing 'thath' the dancer hits the leg in the same place and stretches the hand. The hands when stretched out on sides should be 180 degrees. When the leg is tapped even a little wider the dancer might fall. For this center of line must be considered. The center of line is calculated by the center between the stretched leg and the tapped leg. This position is usually called as Mandala. Simultaneously the hand moves from front to sides, back and again to center. Here the hand forms a beautiful circle on both sides that is on left side and right sides. Here maths is calculated by mind and body. Grace is another term that is related to Mathematics. The beauty of dance is present in grace with which the dancer performs. On over acting or over limitation or under limitation the beauty will be missed. So for each and every action mathematics is an essential one.

Human body and Center point

Center point is again a mathematical calculation. The Natya shăstra created a unique approach to the human body by defining the relationship between the center point, the năbhi or the navel and the verticals and horizontals . It then

coordinated these with the positions and movements of the major joints of the neck , pelvis, knees and ankles and subsequently with the emotional state and expressions. Natya shăstra enumerated several standing and sitting positions based on these concepts. As a result numerous dance poses and postures such as chări and karanas are built on a system of medians (sutras) measurements (manas) Symmetrical and Asymmetrical postures (Banga , ,dvibanga , Tribanga) and sthănas (position of sitting. standing and reclining). In nrutta the concept of perfect symmetry is existent as evidenced by the name Sama.

Triangles and Bharathanatyam
Sacred Geometry



In Nataraja Statue there are Mandalas or Circles. They translate complex Mathematical expressions into simple shapes and forms .In the Circle of Nataraja a Phi based geometric shapes produce interesting designs like triangles which are formed by linear transverse lines.

Triangles in Bharathanatyam

While performing Bharatanatyam the artist imagines her body being made up of many triangles and her movements is space is either strait lines or triangles. The dancer's primary pose in Bharatanatyam is one, the Araimandai in which the body is split into a sequence of triangles according to Dr, Kapila Vatsayana

1) The base of the first triangle is produced by the line connecting the shoulder points and the apex is made by the waist (NAVEL)
2) The spread arms which form another triangle in space on either side of the vertical median add an inverted triangle.
3) Another triangle is constructed with the waist as the apex and the line connecting the out stretched knees as a base
4) Another triangle is formed with the line connecting out stretched knees as a base and the apex at the heels. This is an inverted triangle.
5) When the hands are on the waist then another two triangles is formed with the apex face outwards on sides.
6) When the hands joined together to say namasthe form an isosceles triangle

Araimandi and Mathematics

Artha mandala (Araimandai) is the flexed knee stance is an intrinsic body posture and a fundamental part of Baratanatyam nearly the entire dance is performed in this position. This is the position where the baratanatyam starts. This is based on the mandala concept in which the human body is thought to represent the universe's wholeness and harmony. In other words the human body is envisioned as a diagrammatic depiction of the world. It is also distinguished as a concentric arrangements of geometric shapes .Mandala is the standing posture in dance. Out of Ten Mandala bedas (standing postures) Artha mandala or araimandi also known as the Ayata Mandala is defined as " Standing in Chaturasra " Bending the knees slightly and obliquely and maintaining a space between the two feet .

"Vitastrya antaritau paadau krutv tu chatursrakau.
Triyak kunchita janubhyam sthithirayath mandalam" - Abinaya Darpanam - 263

Chaturasrya is a squarely body composition, primarily in relation to the chest which speaks about the shape Square. Abinaya Gupta says that the very vital principle of the body in dance is based on the square position

" Chaturasrya - mulam Nrttena angasya jivitham " - Abinava Gupta

Ayata mandala is placing heels together and the toes facing outside with the knees bent at a distance of 24 inches. As a result the standing upright position without hunch is an important aspect of Arainandi. Further more the distance between the navel and the head should be the same as the distance between navel and the ground. The performer must sit half sitting or at a height of 3\4 of her height in this position. In the Araimandi the dancer taps the floor with both feet in (Half sitting) stance, with the heels of both feet together and the toes directed in opposite directions forming a diamond shape between the thighs and legs. The Araimandi is quite similar to the western ballet Demi – plie with a greater focus on the knee turn out.

Group dance in Baratanatayam

Vertical line formation. in Group Dane

Horizontal line formation in Group Dance

The shapes come into use in Bataratanatyam are the formations that the group dancers make. The group dancers when they are in multiples, they stand in a particular shape and this shape belongs to one of the geometric shapes 1) Semicircle, 2) Circle, 3) Square, 4)Rectangle. In group dance the dancer calculates the distance between the other dancers and objects throughout the performance. They adjust the distance in response to the different size or shape of the space they perform in. The numbers and geometric shapes that form the core of this ancient dance forms. This is focused on the geometrical shapes and natural angles that the axis of the body makes the limbs while dancing. Most of the postures from Temple sculptures are characterized by three angular nodes, linear formations like straight lines and circular lines .Besides in geometry everything in dancing has to do with patterns. Dancers memorize the patterns in to steps while performing. The rhythm in music usually consists of patterns in the form of beats Formations plays a major role in group dance performances. The dancers stand in a specific formation so that each of them can distribute equal space to dance and also to make sure their performance reach the audience. Usually the positioning is done in such a way that one dancer placed behind the other or in between two. This involves quite a good mind calculation .Only by finding a midpoint in a line we will be able to find the midpoint between two people. The formations could be Circle, half circle, pentagon, octagon, square, slanting lines, wavy lines and many more. So all most all the shapes come into use for making a formation in dance which is maths (space) oriented.

Semi-Circle formation in Group Dance

Numbers in Baratanatyam

The teachers repetitive counting numbers 1. 2. 3. 4. For training the beginners is mathematical base. Every step taught in a class is broken in to counting intervals to facilitate the learner to grasp the speed and rhythm of the steps. Later sollukkattu are alternated for the numbers for example. Thei yaa thei yee. Thei thei thei thei and so on. Depending upon the tala the numbers vary. For Adi tala the count will be 1, 2, 3, 4, 5, 6, 7, 8.For Kanda chapu tala in the form of 5 that is 12. 123 (taka takita). For Misra chapu tala in the form of 7 that is 123 1234 (takita takadimi). As we look closely into these dances we can see that they are made of rhythm, shape and patterns. This can be linked to the mathematical concept. In Maths several patterns are used to predict and explain various equations and formulas like dance. The combinations of quick and slow steps are often made by rhythm or meter of the music in the form of Jathi. In dance rhythms are expressed in fractions for example the graham position of starting can be samam (whole) after one unit 1\4 , after 2 units 1\2, after 3 units 3\4. Also in between jathis fractions are seen in the form of silence. In jathis all thirmanam will be in the form of fractions that is three fives (tatikinatom tatikinatom tatikinatom) or three sixs (tati,kinatom tati,kinatom tati,kinatom)

Symmetry in Dance

Dancers move exactly the same way and the same time as if only one person is moving .When dancers move on both sides their body, hands, heads together create symmetrical shapes they balance each other in space and produce visual symmetry. In Maths symmetry means that one shape becomes exactly like other even when you move it, turn it, flip it or slide it. The dancers also perform the same while dancing. Symmetry is very important in dance when they form patterns. Movement of single body can be symmetrical for example a glide reflection long with time axisand a dancer can execute a pattern of movements by repeats. On the global scale the symmetries are seen between groups of people moving. Symmetries inter act with each other by using four symmetries. 1) Translation. 2) Mirror Reflection 3) 180 degree Rotation 4) Glide Reflection.

Findings

Mathematics provides an effective way of building mental discipline and encourages logical reasoning and mental rigor. It plays important role in understanding the other subjects like Science, Social science even music and fine arts. Applied Mathematics is a branch of mathematics concerned with applying mathematical knowledge to the subjects inspires and uses new mathematical discoveries and can even lead to the creation of wholly new science .

Conclusion

It is highly impossible to perform Baratanatyam without Mathematical knowledge. From the basics to performance Mathematics holds an important role .Each and every single movement are performed with time calculation. Right from Araimandi, Adavu, Abinayam, Performing all dance forms like Varnam, Swara jathi, Jathiswaram,Padam, Javali, Tillana, Daru and Dance Dramas Mathematics hold an important place. So without Mathematics there is no Baratanatyam.

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CITE AS

Prof.S.Subbulakshmi. (2023). Mathematics and Barathanatyam. Global Journal of Research in Humanities & Cultural Studies, 3(1), 28–32. https://doi.org/10.5281/zenodo.7700028