

An Ethnomathematical Exploration of Warli Art and its Integration with Teaching Mathematics

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Abstract

In this paper we examine mathematical aspects of traditional art from the Warli culture of western India. The corresponding symbolism of the artwork is also analyzed. Observations include that most Warli art is made almost exclusively with triangles, circles rectangles/squares, and spirals. Moreover, the spiral shape represents the cycle of life, squares are used for the depiction of weddings and represent land, circles are used to represent the sun, moon, and Earth goddess, and triangles are used in the drawing of people and other important objects. In addition, the images and scenes in Warli art exhibit the close cultural ties they have with nature. Furthermore, the intentional style of Warli paintings depicts an abstraction of simultaneous images that are comprehended as a whole. Some examples are described that could be used in classroom activities to study geometric and numerical patterns that display the cultural context of Warli artwork.

Marathi

या पेपरमध्ये, आम्ही पश्चिम भारताच्या वारली संस्कृतीतून पारंपारिक कलेच्या गणितीय बाबी तपासतो. कलाकृतीच्या संबंधित प्रतीकात्मकतेचे विश्लेषण देखील केले जाते. निरीक्षणामध्ये हे समाविष्ट आहे की बहुतेक वारली कला जवळजवळ केवळ त्रिकोण, मंडळे, आयत/चौरस आणि सर्पिलसह बनविली जातात. शिवाय, सर्पिल आकार जीवनाच्या चक्राचे प्रतिनिधित्व करतो, चौरस लगनाच्या चित्रणासाठी वापरले जातात आणि जमिनीचे प्रतिनिधित्व करतात, सूर्य, चंद्र आणि पृथ्वी देवीचे प्रतिनिधित्व करण्यासाठी मंडळे वापरली जातात आणि लोक आणि इतर महत्त्वाच्या वस्तूंच्या रेखांकनात त्रिकोण वापरले जातात. . याव्यतिरिक्त, वारली कलेतील प्रतिमा आणि दृश्ये निसर्गाशी असलेले घनिष्ठ सांस्कृतिक संबंध प्रदर्शित करतात. शिवाय, वारली चित्रांची हेतुपुरस्सर शैली संपूर्णपणे समजल्या जाणाऱ्या एकाचवेळी प्रतिमांचा एक गोषवारा दर्शवते. काही उदाहरणे वर्णन केली आहेत जी वारली कलाकृतीचा सांस्कृतिक संदर्भ दाखवणाऱ्या भौमितिक आणि संख्यात्मक नमुन्यांचा अभ्यास करण्यासाठी वर्गातील उपक्रमांमध्ये वापरली जाऊ शकते.

Introduction



Figure 1. Warli Art on the side of a building. Image [craftsvilla.com](https://www.craftsvilla.com).

School mathematics is often considered a tough and boring subject that has no connection with art and culture and is limited to only abstract calculations of numbers and digits, and drawing different shapes. These days some educationists are focused on making mathematics more interesting by connecting it with different art forms and allowing the teaching of mathematics and art to be integrated. This article focuses on traditional Warli art of India in the context of its culture and mathematics. Highly symbolic and utilizing geometric shapes, traditional Warli art depicts a geometrically influenced description of the close connections between nature, social relations like marriage, and Warli cultural beliefs. Our goals in this study

are twofold. One is to present a description of some cultural and mathematical aspects of Warli art of India as part of a preservation of indigenous knowledge. Indeed, Stevens (2008) points out the numerous ways in which indigenous cultures are disappearing worldwide, while Magni (2017), Lipka (2020) and Wehi et al. (2019) indicate important benefits to understanding indigenous knowledge in contexts such as ecology and biodiversity. These considerations make it an important task to document some aspects, in our case mathematical ones, of indigenous cultures. The second goal is to give some indication of how cultural aspects of Warli art could be used in mathematics classes of various levels. Experience with art can connect with learning mathematics. For example, Fatma (2018) indicates, “The visual art experience brought them into contact with concepts in mathematics and science” (p.25). Thus, as part of our knowledge preservation goal, we hope to create some insight among the teachers regarding the mathematical aspects present in Warli art forms, by way of examples of how Warli mathematics and culture can be integrated into a mathematics class. Our examples are inspired by activities and exercises described in Barta et al. (2014) and Gilsdorf (2012).

In this study motifs were collected through secondary sources for an exploration of ethnomathematical concepts of Warli art. Figures 1 and 2 show examples of Warli art in which appear figures of spirals, triangles, and other geometric forms.



Figure 2. Traditional Warli art example. Image from Artisera Blog.

A brief history of Warli culture and art

The Warli culture is from a region in western India. Every country has its variety of cultures, traditions, and arts, etc. which have more significant values for the people of that region or community. India has been known as a land that portrayed cultural and traditional vibrancy through its conventional arts and crafts Sodhi et al. (2016). India has many tribal communities that have their own cultures, traditions, arts, languages, and beliefs. Some have dissolved their uniqueness with the development and modernization and some are still following their traditions and art, and even trying to spread their art and culture all over the world, for example, through the publication and sales of items made by traditional artists. One of the tribal communities is Warli, in which we see that they have a unique style of art. The traditional medium of this art is walls of houses in which scenes are painted. This style, referred to as *Warli Paintings*, takes its name from the Warli culture of Maharashtra (Singh, 2017).

The term Warli or *Varli* has is derived from the word 'varal', according to Dr. Wilson in the *Thane Gazetteer* from 1876. The term *varal* refers to a small piece of cultivated land (Deka & Bhadoria, 2018; Semlambo, 2018). Warlis speak the Varli language, classified as Konkani with some degree of influence from Marathi, (Ghatage, 1969). In traditional Warli culture, no system of writing was used.

The Warli people reside near the base of ranges of the Sahyadri mountains which spread in an area north of Mumbai viz. Javhar, Dahanu, Talasari, Mokhada, Wada, Palghar village (Pandey, 2020; Patil, 2017; UNDP, 2020). They build their own dwellings as square bamboo huts coated with mud and cow-dung (Patil, 2017) and use these mud walls as a canvas to execute their expressions in the forms of human beings, animals, and nature in general. Traditionally, these paintings have been done by women folk artists (Pandey, 2020). The paintings are typically done at a time of ritual function or a marriage ceremony (Patil, 2017). Warli painting is considered to be a very old cultural activity. Indeed, the images are similar to those done between 500 and 10,000 BCE in the rock shelters of Bhimbekta, Madhya Pradesh (UNDP, 2020). In 1770 this connection was retraced and recognized (Pandey, 2020). The themes of the paintings are hunting, dancing, farming, fishing, rituals, and day-to-day life activities (Pandey, 2020). The style of Warli painting was not formally recognized as an artistic style until the 1970s. (UNDP, 2020). Since the 1970s Warli traditional artwork has been popularized as paintings on canvas, paper and other mediums, as a consequence of various external influences (Semlambo, 2018).

Married women play a central role in creating their most important painting called *Chowk* (*Chawk*) to mark special occasions. This square painting shape is generally associated with

rituals of marriage, fertility, harvest, and the new season of sowing. Cultural discussions of the Warli Chowk appear later in this paper.

According to the Government of India (2013), traditional materials used to make Warli paintings include the following terms: *Shen* (Cow dung paste, mixture of fresh cow dung and water), *Geru /Lal Mati* (Earth Mixture or Red Ocher mixed with water to form a fine paste), *Pitha cha rang* (Rice Powder paste) and bamboo sticks that are crushed at the end to form a brush (p. 79). To make Warli paintings traditional techniques and tools are used, with terminology such as *Lipane* (to make leveled & smooth background for painting, on walls coated with earth), *Saravane* (which refers to making an austere background for painting, of walls coated by Geru or cow dung), and *Lihane* (the term that refers to making painting on the wall with rice paste by using the bamboo stick). (p. 79).

Mathematical concepts in Warli art

Traditional Warli paintings utilize a set of specific geometric forms: circles, triangles, and squares. Patil, (2017) indicates: “Warli paintings use a very basic graphic vocabulary; a circle, a triangle & a square” (p.453). These basic forms are used to create virtually all of the images of the work. In (Resource Centre for Traditional Paintings, n.d.), we find that “All paintings are based on geometric shapes ...” (p.5), and later, “Warli painters systematically used the simple circle, squares, triangles and align all these geometrical shapes to create wonderful motifs.”, *ibid*, (p.7). For example, figures of people are created from two triangles in which an inverted orientation represents the upper body while an orientation with one side as a horizontal base represents the lower body. This description can also be seen in (Pandey, 2020, p. 354). To distinguish between male and female, female shapes show a small circular shape on the head while male figures have a simple circle on the head. Such images can be seen in Figures 1 and 2

of the human figures. Figures of animals such as horses or cows are created by this same idea except with the triangles oriented horizontally. Another feature is the creation of spirals from a large number of pairs (female and male) of human figures. In general, the measurements must be quite precise so that the spiral appears almost as concentric circles. A particularly important figure is referred to as a *Chowk Square* (also called *Warli Chawk*, or *Chowk*). These are square or sometimes rectangular frames that contain figures within, mainly based on marriage iconography. Moreover, Dalmia, (1984), reiterates the geometric basis of Warli paintings as indicated above, by describing the Warli Chowk as “an elaborately ornamented square consisting of triangles, circles, diagonals, chevrons, and other patterns” (p.80). See Dalmia (1984) for more details on the Warli Chawk.

Cultural symbolisms of geometric forms

In traditional Warli culture, specific geometric shapes and forms are tied to cultural symbolisms. First, let us examine the spirals that often appear in Warli paintings. Such spirals represent the Tarpa dance, where *Tarpa* is the name of a traditional Warli musical instrument (Patil, 2017, p.453). In the center of the spiral the Tarpa player performs a song while women and men are shown arranged in the spiral shape. In Gaur & Das, (2013) we find that these spirals represent: “The Tarpa’s open-ended spiral formation symbolizes the cycle of life” (p.124).

An important shape is that of the square or rectangle. The square represents a piece of land (Deka & Bhadoria, 2018; Semlambo, 2018). Sometimes a square is used to make a base of images of huts and carts (Deka & Bhadoria, 2018). This shape is used in the special context of marriage, in the previously mentioned context of the Warli Chawk. The Chawk consists of an outer perimeter that is usually formed from intersecting triangles. Inside the square are figures

related to the marriage ritual. Specifically, there is a figure of *Palghat*, the goddess of marriage. As Gaur & Das, (2013) explain, “Palghat is the Warli’s marriage deity, otherwise known as their great mother goddess of fertility” (p. 124). In addition, Patil (2017) makes the same observation regarding the interior of the Chawk, “..., palaghat, the mother goddess symbolizing fertility is found” (p.453). The work by Dalmia (1984) is devoted entirely to the Chawk, and in it, one finds descriptions such as, “Inside the square stands, ... the goddess Palghat without whom no marriage can take place” (p.80). Of particular note is the fact that the square, as a geometric object, has a special meaning because it does not originate from an obvious connection with nature. Indeed, Patil (2017) indicates, regarding the geometric forms used in Warli art, “only the square seems to obey a different logic and seems to be a human invention” (p.453).

Another shape is the triangle. It is the main shape used in numerous parts of the painting. Triangles represent the hills, mountains, and pointed trees (Deka & Bhadoria, 2018; Semlambo, 2018). Moreover, two vertical triangles joined at vertices are used to draw humans, and two horizontal triangles joined at vertices are used to draw animals. The triangle is used in other places like decorating Chawk borders by using it in different patterns; these are called Dhak, and Bashinga (Resource Centre for Traditional Paintings, 2021, p. 18).

Circles have a special meaning as well. In the Chawk Square described above, the circle symbolically represents the mother goddess, as explained by Dalmia (1984), “The circle seem to be symbolic of the mother-goddess as the womb” (p.85). The circle also represents the sun and moon, as described in Semlambo (2018), and additionally we see in Patil (2017), “... the circle representing the sun and the moon ...” (p.453).

There is a general symbolism of traditional Warli paintings as depicting their close and religious connections with Nature. Indeed, according to Khandekar (2019b), “Warli people are

very close to Mother Nature and follow the disciplined life as nature follows and for painting also they follow certain rules like the purpose, occasion background and medium of the painting ...” (p.117). Meanwhile, Singh (2017) indicates that the Warli people have a respectful view of nature and view it from a religious (pantheon) perspective (p. 7). Gaur & Das (2013) explain it this way, “The paintings are a manifestation of their relationship with nature and with their deities ... and the rituals represented in the paintings contained symbolic references to their magico-religious beliefs and practices” (p.123). Referring to the themes used in Warli paintings, Patil (2017) lists, “Their folk dance, daily life routine, Nature, gods and goddess, animals, birds, ...” (p.453). Furthermore, in (Resource Centre for Traditional Paintings, n.d.) we find, “This art is the symbolic communication with their deities and nature” (p.6), and, “Their respect for nature is from the most gigantic to the smallest creature and plant” (p.12).

Finally, there is an overall style to the traditional Warli paintings that include an aspect of symbolism. Specifically, the style is such that one sees the entire scene together, without foreground or background emphases. Dalmia (1984) refers to Warli paintings in terms of abstractions in which “two complementary aspects of each (and) cannot be seen in isolation” (p.89). Gaur & Das (2013) describe this symbolism as follows: “Warli paintings commonly feature a spatial juxtaposition of simultaneously and sequentially occurring events ... The lack of foregrounding results in ... a single frame, making it hard to ‘read’ a Warli artwork without sustained engagement.” (p.124–125). This encompassing symbolism is also described in Hoskote (1996) as follows: “Space is conceived of as two-dimensional; no part of the picture area is permitted to remain except when blank zones are a component of the design” (p.83).

Changes in Warli paintings in recent times

In recent years, the style, medium of expression, and the gender of the artists of Warli artwork have changed. We begin with gender: Traditionally, Warli paintings were made by women, as clarified by Pandey (2020), “Warli is the traditional tribal folk-art ... done by the women folk artist” (p.354). In (Resource Centre for Traditional Paintings, n.d.), we find, “Basically this art is considered as the art of Warli women” (p.7). This practice has changed such that much of Warli artwork is now done by men. Khandekar (2019b) focuses on this aspect, for example, in “It [Warli art] has now become the commercial activity of Warli men” (p.116), and later, “Significance of the art has changed, earlier it used to be a social and religious tradition and ritual for women ...” (p.118). We see, in Patil (2017), “Traditionally this art was exclusively done by women but with commercialization and greater demand, it as become the domain of male artists” (p.456).

The themes, medium, and subject of the painting are changing according to the requirement of a painter and a buyer, as well (Khandekar, 2019a, 2019b). Traditionally Warli art was made on one whole wall of the houses of Warli people but with modernization paper, fabrics, canvas, wood, metals, plastic, and other items are used as a base. Warli people utilized art to express basic themes, such as their day-to-day life activities like hunting, farming, fishing, etc. Nowadays, it is used to depict various modern themes like office work, city life, school buildings, factories, etc. according to the demand of the market (Khandekar, 2019a, 2019b). Anciently, red colour (Geru or Red Ocher) and light brown-yellowish colour (cow dung paste) for background and white colour (Rice powder paste) were used but with time color shades have also changed. These days various colors like blue, black, pink, purple, grey, etc. are used to make Warli art. This shift is also seen in the tools to make Warli painting. Nowadays, paint brushes

are used in place of bamboo twigs to make the painting. Traditionally the rural women used circles, triangles, and lines to make human figures and animals but now modern artists use different geometrical shapes. Examples that fuse the traditional style of Warli art with modern imagery are in the form of advertisements, animations, and other means of presentation. One instance of such modernization appears in an advertisement for Coca-cola (<https://www.youtube.com/watch?v=nMIBUvqQ8V8&t=58s>, <https://www.youtube.com/watch?v=nMIBUvqQ8V8>). One can see that Warli art is used very effectively and innovatively.

Classroom Examples

The objective of the examples of this section is to give readers some ideas of activities related to the cultural aspects of Warli art that can be created in a mathematical setting. In Barta, et al. (2014), in particular, Chapters 4 and 10, and in Gilsdorf (2012), in particular, Chapter 5, the reader can find more detailed descriptions and further examples of classroom activities and exercises that are relevant to our discussion here of Warli artwork and cultural mathematics. In each of the examples outlined below, a preliminary classroom discussion would take place in which students view a number of examples of Warli art and express their general observations, and some description would be given of the Warli culture regarding the geography of where they live, the language and history of their culture, and some of the symbolism expressed in their artwork. If students are able to view examples of Warli artwork of both older and more modern images, then some comparisons regarding how the style of artwork has changed over time could be discussed. Information from this article as well as from the references in this paper could be helpful. In addition, if reasonable, a person familiar with Warli culture and art could be brought to the class to discuss these ideas directly with students.

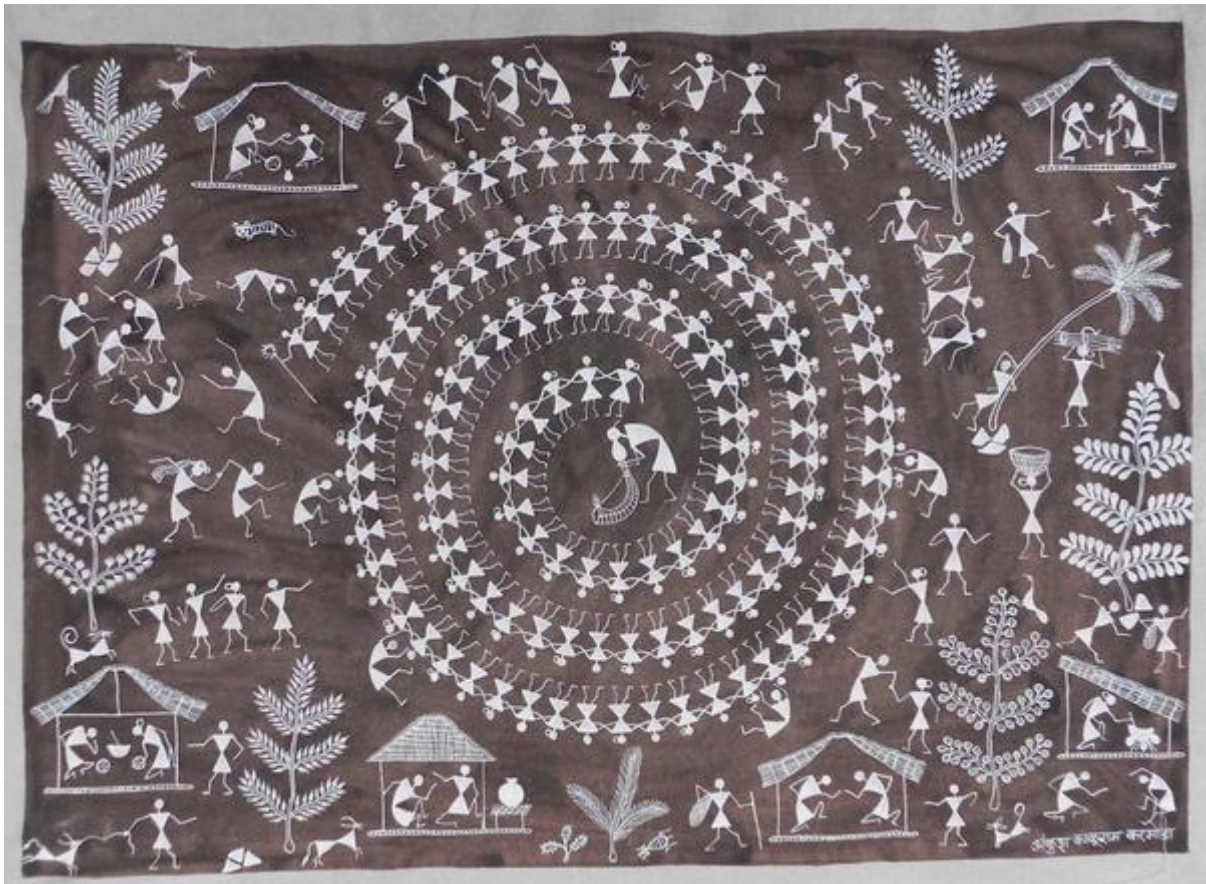


Figure 3. A Warli Tarpa Dance scene. Image from Artisera Blog.

Example 1, Elementary school level, (grades K – 3): Please see Figure 3 as an example. After the introductory discussion mentioned before Example 1, students could observe a variety of Warli images, including, if possible, both older and more modern. Some questions at the elementary school level related to the figure could include:

- (a):** Explain some activities that women are doing in the figure and some activities that men are doing in the figure. How did you determine your responses?
- (b):** Observe the spiral in the figure. Can you see a connection between the figures of the spiral and the concept of even and odd numbers? Note that in some schools (for example in India)

students are exposed to even and odd numbers. For school curricula for which even and odd numbers are not introduced until later grades, this activity can be moved to that category (such as later elementary or middle school levels - see Example 2 below).

For students more familiar with standard geometric shapes, one could ask:

(c): How do you think the images of people are drawn? This question can prompt the students to notice the use of triangles, squares, rectangles, circles, spirals, and so on in the Warli artwork, which could lead to an in-class activity in which students draw some figures using only these shapes. An example could be to draw an elephant using only these shapes.

Example 2, Later elementary school to middle school (grades 4 – 8): After the introductory discussion mentioned before Example 1, students could observe a variety of Warli images, including, if possible, both older and more modern. Students could divide into groups, each one with a distinct Warli painting image to work with. One activity each group could do is to make a table of geometric figures that appear in the image such as those listed in Example 1, in which each type is listed, along with a tally count and a frequency count. See (Barta, et al. (2014), Table 4.2, p. 54, for comparison. The following are the kinds of questions that could be considered:

(a): Given the tallies of the various images, which ones appear to be of an older style and which appear to be of a modern style? Please explain your reasoning.

(b): Which geometric shapes appear most often and which appear least often? Why do you suppose that is?

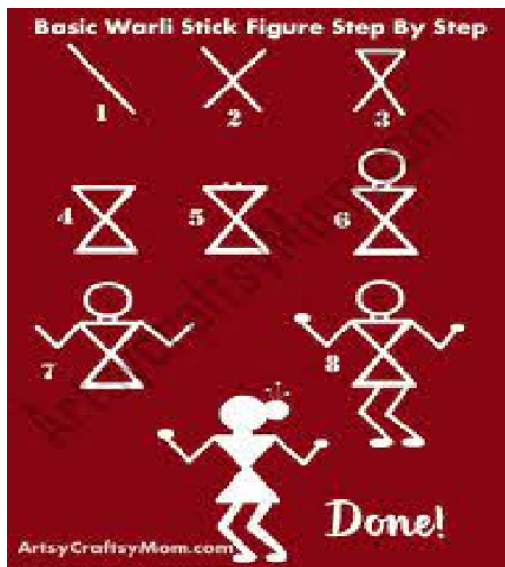
(c): Either in groups or individually, students could create their own Warli images, from their daily lives, culture, and so on. In view of the fact that a characteristic of Warli paintings is the use of only two colors, an important feature of this activity is that only two colors be used. The

instructor could ask the students to explain why only two colors are used. After finishing their drawings, students could explain some details of their image, including any symbolism they incorporated into their work.

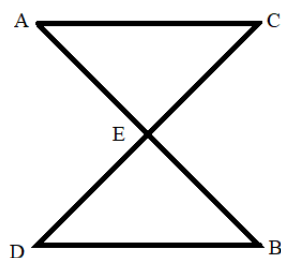
(d): At the end of the activity, a general discussion of the connections between geometry, culture, and symbolism of Warli art could take place.

Example 3, High school (grades 9 – 12): After the introductory discussion mentioned before Example 1, and observing a variety of Warli images, the following activities could be done in class:

(a): For students familiar with properties of intersecting lines, parallel lines, and triangular shapes, the following could be done: First, review constructions of geometric figures such as circles, squares, and triangles. Next, consider Figure 4 below.



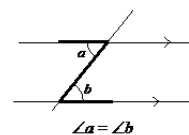
(a)



AB & DC are intersecting line.
AC & DB are parallel lines.

Alternate Angles

Angle ACD = Angle BDC
Angle CAB = Angle DBA



(b)

Figure 4. (a). Drawing Warli figures. Image from Artsy Craftsy Mom.

(b): Geometric diagram by Shalini Verma.

Using the outline shown in part (a), draw a figure of a woman that might appear in traditional Warli art. Discuss the construction as described in part (b) of Figure 4, as part of the process.

Now look at images of humans in traditional Warli art, as shown in Figure 5. How are they different than the figure constructed using Figure 4? How could you draw a human figure so that it appears as in Figure 5?



Figure 5. Warli art. Image from Artisera Blog.

(b): For students who are familiar with other geometric objects such as conic sections, one could ask them to observe an example of Warli art and then consider questions like: Are there any ellipses, parabolas or hyperbolas in the figure? Why or why not?

(c): For students who have studied more advanced graphing techniques, one could have students observe several Warli images that contain spirals. In groups, students could then sketch the graphs of spirals of the form $r = k*a$, where k is a positive constant and a is a positive angle. Different groups of students could sketch the graphs for different values of k . Afterward, students could discuss which value of k produces a spiral that most resembles a typical Warli spiral. Further discussion could focus on how a Warli artist would create a spiral figure like

those viewed at the beginning of the lesson. It would be useful to point out that traditional artists most likely would draw such spirals from memory and not with the use of equations, sketching graphs, or similar techniques. In addition, students could discuss cultural aspects of the spirals in Warli art, including what the spirals typically symbolize. Finally, students could discuss the typically alternating figures of men and women that appear in spirals, and connections with even versus odd integers, base two counting, and related concepts.

Example 4: For students in courses on cultural mathematics (ethnomathematics), anthropology, ethnohistory, or other related disciplines, the following are possible essay or discussion questions:

(a): Explain the cultural meaning of each of the main geometric figures of Warli art, including triangles, circles, spirals, and squares.

(b): Discuss the aspects of gender roles in Warli art. How have gender roles changed with respect to Warli art production? Compare aspects of gender in Warli art with aspects of gender in the mathematics of some other cultures, including Western culture.

(c): Discuss the mathematical and social changes of Warli art that brought on by the modernization and popularization of Warli art.

(d): Discuss how Bishop's Six categories of mathematical activities are manifested in Warli art. Refer to Barta et al. (2014), Bishop (1988), or Gilsdorf (2012) for more details on Bishop's Six.

Conclusions

When a traditional Warli artist begins to create a painting, several mathematical processes also begin. Such processes include making use of geometric shapes and their properties, several representations of symbolism that have deep cultural connections, and an abstraction of depicting the overall scene as being one single event without an emphasis in any

particular part of the painting. Understanding the connections between mathematics and culture that manifest themselves in Warli art is part of the preservation of their culture and is useful for understanding how cultures around the world perceive mathematics in creative ways. By suggesting some classroom activities that could allow students to experience both the mathematics and the cultural aspects of Warli art, we hope to contribute to the overall preservation of indigenous knowledge.

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