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Ethnomathematical Ideas in Dhakiya Weaving in Tharu Community

Parshuram Chaudhary[1,*], Dinesh Panthi[2], Chet Raj Bhatta[3]

[1]*Nepal Sanskrit University, Janata Vidyapeeth, Bijauri, Dang, Nepal*
[2]*Nepal Sanskrit University, Valmeeki Campus, Kathmandu, Nepal*
[3]*Central Department of Mathematics, Tribhuvan University, Kathmandu, Nepal*

Abstract

The indigenous people Tharu have a distinctive culture and way of life. While performing daily tasks, they practice their own mathematical concepts and thinking. The study of mathematical ideas and skills that are common within a population but are often not included in the formal curriculum is known as ethnomathematics. This study intends to reveal the secret ethnomathematical expertise and knowledge used in Tharu community Dhakiya weaving. The observation and documentation analysis approach were utilized in this study's data collection to attain its objectives. Under the photograph of the Dhakiya is redrewn to better illustrate the art and designs of the Dhakiya weaving techniques. Emic ethnomodeling is used to look at the mathematical ideas weaved within Dhakiya. The findings indicated that intricate mathematical ideas and concepts like the center of a circle, radius and diameter of a circle, concentric circles, concepts of, circumference of a circle, sequence, symmetry, and other geometric shapes are demonstrated in the weaving of Dhakiya in the Tharu community.

Keywords: Ethnomathematics; Indigenous knowledge; Dhakiya; Weaving; Tharu.
2020 Mathematics Subject Classification: 01A07.

1. Introduction

Nepal is a multi-religious, multilingual, and multicultural country. It has diversity in terms of geography, language, castes, ethnicity religion, and cultures. There are 59 indigenous nationalities having distinctive cultural identities. *Tharu* is one of them. *Tharu* is one of the largest ethnic communities in Nepal and they constitute 6.75 percent of the total population [9]. They are the inhabitants of the Terai region from Jhapa in the east to Kanchanpur in the west. They chiefly reside in twenty-two districts of Tarai and the inner Terai region. Even though the term '*Tharu*' is understood as a single community in Nepal, it shows several subgroups based on cultural and

*Corresponding author (parsuc31958@gmail.com)

linguistic diversity within. Moreover, they are also known by a regional basis as *Deukhuriya* and *Dangaura* in the mid-western, Rana in the far-western, *Kochila* in the eastern, *Chitwaniya* and *Desauriya* in the middle region of the Tarai. Each subgroup contains a variety of ethnic characteristics embedded with ethnomathematical concepts that are being practiced in day-to-day activities. So, this study will explore what and how the ethnomathematical concepts exist and how they play role in the *Tharu* community of Nepal.

The purpose of weaving is to create a ribbon out of materials that strengthen one another because the process is a recurring motif. Mathematical concepts can also be linked to the weaving process. Every environmental interest shared by a group of people includes mathematical thought and inquiry. They keep a significant portion of the mathematical knowledge necessary to carry out their routine tasks secret, though. *Tharu* people have been making mats, hats, and other items out of weaving for a long. Unique cultures have succeeded in weaving using unusual materials. The concepts of pluralism have been used to study the mathematical activities in major spheres of their lives, their methods for comprehending the cultural artifacts, and their implicit mathematical knowledge. The mathematical concept that is ingrained and used in the culture activities of a group of *Tharu* people is known as ethnomathematics. The term ethnomathematics is coined from different perspectives. Numbers of scholars define it in different ways. For [2], ethnomathematics is the study of the mathematical ideas of non-literate people. Others believe that it is the methodological postures used in the teaching and learning of formal mathematics [5]. Ethnomathematics helps to conceptualize abstract mathematical ideas by connecting children's everyday activities. In [4] view, ethnomathematics is a research program about the history and philosophy of mathematics and it is also the program of how cultural groups understand, articulate, and use the concepts and practices, which is described as mathematical, whether or not the cultural group has a concept of mathematics. Further [4] defined ethnomathematics as "the mathematics which is practiced among identifiable cultural groups such as national-tribe societies, labor groups, children of certain age brackets and professional classes".

Ethnomathematics has emerged as a strong pedagogical program that enhances the teaching and learning mathematics in school and adult education curricula [1]. Ethnomathematical approaches are intended to make school mathematics more relevant and meaningful to students to promote the overall quality of education [6]. Thus, ethnomathematics is a pedagogical action that connects students' everyday experiences and practices to school mathematics. In the Nepalese context, ethnomathematics has been considered the area of research of diverse mathematical ideas by indigenous peoples. Now, the ethnomathematical ideas of different groups of people and mathematical concepts practiced in the out-of-school context have become part of teaching and learning. Teachers now are trying to connect their cultural and local ways of teaching practices with curricular activities [8]. Bishop [5] stated that mathematics is a cultural product, that has developed as a result of various activities, and that counting, locating, measuring, designing, playing, and explaining are all part of that cultural product. Everyday life is impregnated in the knowledge and practices of a culture. At all times, individuals are comparing, classifying, quantifying, measuring, explaining, inferring, generalizing, and evaluating, using material and intellectual instruments that belong to their culture [4]. The main objective of this study was to explore the ethnomathematical ideas embedded in the activities in *Dhakiya* weaving in the *Tharu* community of Nepal and intended to answer the following research questions. What mathematical ideas are embedded in the *Dhakiya* weaving activities? How do *Tharu* people generate mathematical knowledge in *Dhakiya* weaving activities?

2. Conceptual Framework

The major goal of this paper is to link the learners' outside-of-classroom mathematical concepts and expertise with their academic mathematics. The conceptual framework created for this study, weaving *Dhakiya* is a cultural activity that can be used to teach and learn school mathematics in a constructivist context. Without formal mathematical training, people weave *Dhakiya* to practice mathematical concepts. In this framework, two realms of the physical and mathematical worlds are centered around ethnomathematics. In this study, we argued that the comprehension of school mathematics can be mediated by the ethnomathematical concepts ingrained in the weaving process. Everyone should have a basic comprehension of mathematics, and they use this knowledge and understanding in their daily activities. The concepts and knowledge of mathematics are implicitly employed in *Tharu* culture. This framework enables a broader range of cultural activities for pupils that may use formal mathematical concepts. It implies that by using ethnomathematical concepts, it is possible to connect academic mathematics to non-academic contexts.

3. Methods and Procedures

The goal of this study is to investigate the role played by ethnomathematical concepts in a group of people's activities and in the transmission of knowledge through generations. We consistently positioned ourselves as qualitative researchers to achieve the goal of our research. The precise qualitative research approach was the only thing we needed to decide on when we started this study's design. We described, interpreted, and unveiled the significance of cultural diversity using ethnography. To characterize, analyze, and make sense of cultural practices related to ethnomathematical concepts found in Dhakiya weaving, we used ethnography. We consistently addressed the issues of interest pertaining to the mathematical concepts woven into the Dhakiya weaving process as well as their methods of instruction and learning within their cultural contexts while performing this research. In studying the latent mathematical concepts and ways of thinking of Dhakiya weavers, we put ourselves in a position to use ethnographic research methods. Because our study aimed to examine their mathematical concepts from the perspectives of Dhakiya weavers (emic) and from a Western mathematical perspective, we used ethnography as our research approach (etic).
Fifteen *Dhakiya* weavers of *Tharu* women, who took part in weaving activities, from the rural Dang

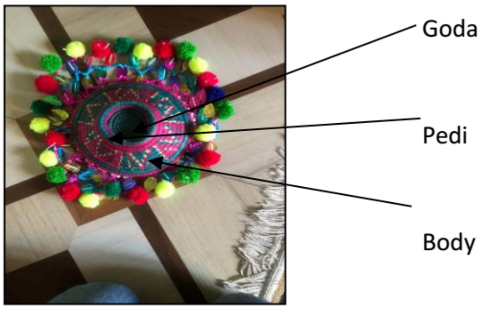
district were purposefully chosen to get answer our research questions. Five of them had never attended school, four were trying at *prodh sikshya* (Education program to elderly people), three had completed primary school, one had completed high school, and two had completed their +2 level. Through careful observation of their actions, attentive listening, and targeted questioning to the group of individuals in a natural setting, the information describing the mathematical concepts woven into the Dhakiya weaving process was collected. Guidelines for interviews and an observation checklist were used to accomplish this. Regarding data collection, field notes were taken to document the group's behavior and activities in a natural environment. With the permission of the research subjects, paper and pencil, photos, videos, and audio recorders were used to create the field notes. With the aid of the video camera, every feasible conservation effort was meticulously documented. All needed data from several sources were collected throughout the course of the research. All the information collected from the many sources was analyzed and then categorized into groups. For ease of analysis and interpretation, the talks and interviews were turned into texts.

The data was interpreted in connection with a variety of potential mathematical ideas. We used triangulation to interpret our results by combining the data with theoretical closures and tried to create accurate descriptions of the items during this procedure. Our study used the concepts of pluralism to investigate the cultural practices in the student's community, their methods for comprehending natural events, and their knowledge of ethnomathematics. By comparing the claims made by different research participants through their handicrafts and formal mathematical knowledge, the analyzed data was validated and made more reliable.

Such weaving is done throughout the world by indigenous people from ages, for example in Charleston, South Carolina area in the United States, people from African origins still practice basket weaving using seagrass. It will be an interesting study to compare these two art forms and for the artists to meet and compare their artifacts and underlying mathematical patterns and knowledge.

4. Mathematical Ideas in Dhakiya Weaving

Weaving *Dhakiya* is one of the common activities in the rural part of the *Tharu* community in Nepal. With the help of a needle (suja) using dry grass (Bankas and Munja), *Dhakiya* are made. To weave a *Dhakiya*, the Dhodi or Pendi (base) is the first component to be created. All participants claimed that the circular base is woven round by round like a spiral conch from the center outward. The handicrafts' size determines the base's size. Since these handicrafts are used to carry products on the head, the size should typically fit the top of the head. As a result, it is slightly larger for *Dhakiya* (for adults) than Nuiya (for tiny children).



The body section is made when the base is finished. By completing the base, the netting process shifts to an upward slope, resembling a conical surface, and the size is chosen in accordance with demand. So, the number of spirals of *Dhakiya* depends on its size. The difference is that the base is made flat while the body part is conical. While knitting the artifacts the women use to keep different types of denominations on its wall which are in different geometrical shapes. The spirals of body parts increase steadily from bottom to top. The upper and outside borders of the spiral are spiraled, causing the *Dhakiya* wall to project outward like a cone.

Finally, a circular base known as Goda (stand) is secured to the base. Goda is woven in two to three spirals. This is circular in shape and pointed downward on the down surface of Pendi. This Goda aids in maintaining equilibrium for the *Dhakiya* on the ground or on top of the head.

Tharu keep easily these artifacts on the ground; one circular base is fixed into the bottom, having no exact measurement. While knitting the artifacts the women use to keep different types of denominations on its wall which are in different geometrical shapes. The women of the *Tharu* society have lots of mathematical concepts before and during knitting the *Dhakiya*.

The technique of weaving *Dhakiya* incorporates a variety of mathematical concepts and ways of thinking. Indigenous people can do tasks and have implicit mathematical knowledge, but they lack the ability to justify their actions. This tacit mathematical understanding is ingrained. The indigenous people also employ many mathematical ideas such as estimate, tessellations, and symmetry in the creation of their cultural practices and artifacts. In their daily lives, *Chundara* people use a lot of mathematical ideas and skills. Their understanding falls short of providing enough support for the rule they have been applying (Pradhan, 2017).

4.1 Diameter and Circumference of *Dhakiya*

If we generalize it mathematically, they start by weaving *Dhakiya* with a needle, but depending on whether they need to make small or huge *Dhakiya*, they build the circle's center and base. But from where we stand, we can both see several concentric circles and show that the radius of a circle is twice as big as its diameter. Symbolically, Diameter $= 2\times$ radius i.e., $d = 2r$. They can weave nuiya (a little Dhakiya) and Dhakiya as needed. But we mathematically explore from the top of *Dhakiya* we can find the value of π. Since the definition of π is a ratio of circumference to diameter, we may measure the circumference and diameter of various circles to arrive at the results shown below.

$$\pi = \frac{\text{circumference of a circle}}{\text{diameter}} = \frac{11\ cm}{3.5\ cm} = \frac{22cm}{7\ cm} = \frac{33\ cm}{10.5cm} = \frac{55\ cm}{17.5cm} = \frac{66\ cm}{21\ cm} = \frac{22}{7}$$

So, for indigenous children will discover that the ratio is a constant and then they are introduced that people call it pi. In this way students can understand the concept of value π. As the definition of π, $\pi = \frac{\text{circumference of a circle}}{\text{diameter}}$ or, $\pi = \frac{C}{d}$ or, $C = \pi\ d \Rightarrow C = 2\pi\ r$. Students will be able to understand the formula used to determine a circle's circumference in this method and won't need to mentally memorize it.

4.2 The perimeter of *Dhakiya* and Arithmetic Sequence

We measure the 2 *Dhakiya* and get the following perimeter from the first small *Dhakiya* by observing the perimeter of all circles from the first *Dhakiya*. Base of the perimeter of is 19 cm, followed by 23 cm for its above-circle perimeter and 27 cm for its above-circle perimeter of, then continually 31 cm, 35 cm, 39 cm, 43 cm, 47 cm, and 51 cm for the top of the perimeter of *Dhakiya*, here we see that differences of the perimeter is 4cm and it is arithmetic sequence. Here, we can observe that the changes in the perimeter are 4 cm, and the sequence is arithmetic, also from the first next *Dhakiya* by observing the perimeter of all circles from the second *Dhakiya*. The base of the perimeter is 16.5 cm, followed by 23 cm for its above-circle perimeter and 29.5 cm for its above-circle perimeter of, then continually 36 cm, 42.5 cm, 49 cm, and 55.5 cm from the top of the perimeter of *Dhakiya*. here we see that differences of perimeter are 6.5cm and it is arithmetic sequence. We conclude that the disparities in circle perimeter for big *Dhakiya* are greater than for small *Dhakiya*. All circles from little Dhakiya have perimeters of 19, 23, 27, 31, 35, 39, 43, 47, and 51 cm. In order to enhance the ratio of spiral perimeters, it appears that they don't adhere to any particular formula. Although it has been discovered through our measurements of some artifacts that the spirals are in an arithmetic sequence.

4.3 Dhakiya and Rotational Symmetry

One of our participants claims that they are creating various designs only for decorative purposes, however we can conclude that there are numerous mathematical ideas have been included. Despite the fact that they don't utilize scales, measurements of various mathematical shapes on the same *Dhakiya* were shown to be comparable. When shaping, varying quantities of various Munja colors are woven to create precise sizes with symmetry of comparable shapes in the same *Dhakiya*. There are many symmetry patterns because the concept of geometrical transformation was applied in the form of reflection, rotation, and translation.

5. Conclusion

In Nepalese *Tharu* people, weaving is a common cultural activity. The cultural values and identities are reflected in the weaving of Dhakiya. The production of the Dhakiya weaving incorporates a variety of mathematical concepts and ways of thinking. When weaving Dhakiya, it was seen that the weaver displayed sophisticated mathematical concepts. At various stages of education, it is suggested that native Dhakiya weaving can be used to teach and learn mathematics. The integration of Dhakiya weavers' ethnomathematical concepts with school mathematics strengthens the complex, relevant linkages between the mathematical concepts of two distinct worlds (home and school), where the children simultaneously live and study. If the concepts presented are based on students' experiences and actions, both the teaching and learning of school mathematics can be improved.

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