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Ethnomathematics and Curriculum: An Ethnographic Study in Limbu Community

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Abstract

This study was carried out to see the indigenous practices and the hidden knowledge of mathematics in the ancient artifacts in the Limbu community. This study aims to explore,how they internalize the phenomenon related to mathematics in their daily life. The entire research process of the study was guided by the Interpretivism paradigm followed by ethnographic design with the observation of documents and daily used artifacts which can be blended into the local curriculum. Nepal is a multicultural, multilingual, multiethnic country with diverse flora and fauna. We have many artifacts and local mathematical practices in different communities. The purpose of this paper is to introduce the concept of Ethnomathematics and its relevance to classroom activities. This paper seeks to provide a comprehensive concept of some of the current and recent scholarly literature concerning Ethnomathematics and the applicability of Ethnomathematics as a practical teaching approach, particularly for underrepresented students.

Keywords: *Ethnomathematics, diverse, artifacts, enculturation, multiethnic, multicultural, indigenous.*

Introduction

Nepal is multicultural, multilingual, and diverse in demographic flora and fauna (Acharya & Bhatt, 2019). Ethnomathematics, as a major component of mathematics in the history and philosophy of mathematics, with pedagogical implications, received an important organizational framework of the mainstream of mathematical developments (Bhatt, 2020). In Western scholarly discussion, there is often an assumption that empirical data and the mathematical calculations that produce them are advanced and more reliable than those produced through qualitative analysis. This assumption is based in large part on the broader idea that numbers and mathematical functions are purely objective, and as a result, are immune to the influence of subjectivity(Rosa et al., 2016). The long-term consequences of this association are evident today in the way that mathematics is categorized in Western society and privileged among other types of analytical activities. The challenge for mathematics education in Nepal is to take a more comprehensive view of the purpose of school mathematics with the goal of providing a more applicable and socially accountable curriculum delivered via contextual resource materials that

engage all students actively in meaningful and relevant learning experiences in accordance with the nation's philosophy of Education For All (UNESCO, 2008).

Mathematicians' pedagogical perspectives and knowledge are discussed by the researchers and the mathematicians themselves in terms of the cultural practices of the two communities of mathematics and mathematics education research (Acharya & Bhatt, 2020, p. 19). Concerning academic objectivity, disciplines such as science and mathematics are often regarded as representing the purest form of analysis, because they are assumed to be independent of the subjectivity of the individual and rely instead on universal truths and facts. On the other hand, disciplines such as literature, history, and cultural studies are often discounted in comparison because of the importance given to the subjective interpretation that is involved in investigations and analyses that are attempted in these fields. What has only recently come to be recognized, however, universal facts and truths that form the foundation of mathematics are, in actuality, deeply embedded in a Western cultural tradition. It is important to recognize that often something we think of as universal is merely universal to those who share our cultural and historical perspectives.

Although these foundational concepts are found throughout much of Western science and culture, there exists a broad array of distinct mathematical systems and methods that have been developed in other cultural traditions and that do not share the same assumptions (Rubio, 2016). While brief surveys of the history of mathematics have always included the assistances of non-Western cultures, such as those of the Egyptians and Mayans, these achievements were typically treated as milestones on the pathway of the development of Western mathematics. Moreover, these topics of attention are rarely, if ever, available to students studying mathematics at any level. However, researchers that have begun adopting a more culturally sensitive approach to the study of the history and development of mathematics traditions attempt to avoid this assumption. Because of the deep degree to which the idea of the universality and objectivity of mathematics is embedded in Western culture, there has been a great deal of resistance to the suggestion that mathematics could be regarded as a product of distinct socio-cultural tradition (Rosa & Orey, 2010).

Pais (2011) argued that many traditionalist mathematicians and scientists have vigorously objected to the basic premise of recent analyses that have attempted to locate mathematics within a specific cultural context. However, among that researcher that sees value in identifying and further exploring the role of culture in mathematics, the initiation of this direction of questioning has led to a series of possible directions for further research, theory, and practical application (Rosa et al., 2016). Proponents of Ethnomathematics argue that culturally diverse mathematical traditions are worthy of validation, acknowledgment, and study in the scholarly community (Rosa et al., 2016).

Ethnomathematics also a culturally sensitive approach to mathematics instruction could prove to be an essential means of introducing underrepresented minorities to mathematical competency (Ambrosio, 2001). Ethnomathematics recognizes the cultural heritage of underrepresented students to build their self-esteem and encourage them to become interested in mathematics.

On the other hand, critics of Ethnomathematics tend to take a more hierarchical approach to the assessment of the value of varying mathematical traditions. While those in this group acknowledge that non-Western approaches to mathematics exist and have been used successfully by many societies, they continue to regard Western mathematics as the perfected endpoint of the evolution of various historical and cultural mathematical traditions (Pais, 2011). Some opponents of Ethnomathematics also accuse proponents of overstating and exaggerating the fundamental differences between Western and non-Western mathematical traditions.

In recent years, the field of Ethnomathematics has expanded considerably (Kandangwa, 2020). Although the idea of placing mathematics into a cultural context has not received universal support, however, François (2010)claimed that at present, Ethnomathematics remains a developing discipline. Reflecting its recent introduction to the scholarly discourse, however, the literature relating to the subject of Ethnomathematics is widely spread, and, in some cases, contradictory. Also, there is a lack of empirically-based data to support the claim that Ethnomathematicsis a better way for students to learn math. As a result, the practical application of Ethnomathematics as a component of mathematics instruction has until now been limited.

There exists a considerable difference in the mathematical achievement of Caucasians of European heritage and many of their counterparts from underrepresented minority groups (Matang, Rex, Owens, 2004). Since the differences in the test scores and mathematical enactment among tribal, ethnic, and cultural groups were measured, a broad range of curative methodologies have been developed and implemented in Nepali public schools. However, despite these concerted efforts, little measurable progress has been made in closing the mathematics performance gaps between racial, ethnic, and cultural groups in the different shires.

Advocates of Ethnomathematics as a field of study have suggested that this disciplinary context may also have practical application as a framework for mathematics instruction. These ideas provided the teachers and students opportunities to add numerous cultural, social, and political dimensions to classroom discourse to build students' identity in terms of "who they are" and "what they want to be like." (Acharya et al., 2021). Besides, the existing published literature relating to Ethnomathematics is characterized by a highly split mix of opinions and broad editorial overviews of narrowly focused research studies. The term itself is not clearly defined and its proponents have yet to agree on a conclusive definition. It's really noticeable that the advocacy for the integration of Ethnomathematics in curriculum is significantly growing.

Research Objectives

The main objective of this study was to uncover the hidden informal mathematics artifacts in our surroundings and mainly practices in the Limbu community of Nepal. Also, interpret the value of the local indigenous artifacts as indigenous knowledge to blend with modern official knowledge starting from policy level by introducing the curriculum. The main focus of my study will around the question, in what ways Ethnomathematics can be used in the mathematics classroom to reduce the anxiety for mathematics students?

Methodology

This study is based on the Interpretivism paradigm (Denzin & Lincoln, 2018) followed by the ethnography approach in which in depth review of documents and observation of artifacts was achieved. How the people understand the same phenomenon with different eye glass, gives the multiple interpretations. In this study, I choose this because different communities have their own values and norms. Ethnographic designs are qualitative research procedures for describing, analyzing, and interpreting a culture-sharing group's shared patterns of behavior, beliefs, and language that develop over time. Ethnography deals with how people behave, how they interact with social reality together with knowledge is shared even socially constructed(Ernest, 2004; Steffe & Kieren, 1994). Ethnography is an in-depth involvement in culture to describe naturally occurring behavior cultural activities of the community by using multi-cultural methods where it was concerned with people's belief, lives experience, and context of a particular time (Khanal, 2018).The data were collected from the observation of ancients' artifacts and the different utensils used in the Limbu community conducted in Chuhandada village of Tehrathum District by the mathematics educators of the universities in Nepal. Through our analysis and discussion of various intellectual sites of ethnography, we make visible how the site shapes what counts as ethnography and how an ethnographic perspective and related practices inform the study of the social and cultural practices within and across social groups(Green, 1997). The people with power are government level policy makers, personnel from the ministries, and political leaders, linguists, educationists and material developers are the people with expertise. Likewise, social elites, who can directly and indirectly influence decision-making processes in society due to their knowledge, skills, and social prestige, are the people with influence (Phyak, 2013), basically they directly or indirectly play vital role for decision making/ curriculum framing even in the crucial organ of the nation.

Results and Discussion

We see the indigenous local mathematical practices in the diverse social structures practiced by Nepalese people however the knowledge is non-official, advocacy of mainstreaming the indigenous practices at the policy level and restructuring the curriculum to blend the modern classroom practices with our natural context is the main goal of the mathematics practitioners and policy makers. Contextualizing and visualizing the Mathematics prescribed in curriculum should be the main concern in the pedagogical praxis. Western mathematicians look for the idea that gives the sense and makes meaning of mathematical scripts in the nature around, while the pedagogical praxis in Nepal seems more theoretical rather looking for its fantastic nature. That is why most of the students have anxiety in Mathematics. There is a philosophical debate that the Mathematics whether discovered or invented? Around the issue the good teacher should contextualize the idea with the local indigenous artifacts that helps for meaningful learning and can significantly reduce the anxiety towards Mathematics.

Mathematics in Dhol. Dhol has great cultural value in the Limbu community. Other names of Dhol are Chyabrung and Kay/Ke. It is the traditional musical instrument of the Limbu community which is cylindrical. This hollow wooden drum is about a foot in diameter and two feet in length. It has two circular faces on either end, each end being tightly stretched by the skin of either goat or bull/cow on the right and left ends respectively. Whereas the use of cow skin was

stopped since, Cow was declared as the national animal. The face covered by goatskin produces a sharp, treble tone. Whilst the face covered by bull/ cow skin produces a flat, bass sound. Sometimes the skin of bull is used on both sides varying the skin's thickness. The curved surface of the cylinder is made up of special types of wood whereas the circular bases are made up of the skin of animals. Similarly, the ropes made of animal skin are used to tie the curved surface with circular bases. The ropes are tied in either parallel way or are crossed. The drum is strung around the neck with a cord at stomach height and played during auspicious celebrations and festivals of the Limbu community. Limbus uses Dhol even in the open ceremony of any functions.

This instrument contains the geometrical concept like curved surface, parallel line, cylinder, and circle. So, Dhol can be the best instructional material for teaching this mathematical concept to the students belonging to this community as they are familiar with Dhol. Dhol itself is cylindrical

Mathematics in Tongba. Tongbais a millet-based alcoholic beverage found in the eastern mountainous region of Nepal and the neighboring places Darjeeling and Sikkim. It is the traditional and indigenous drinkof the Limbupeople of eastern Nepal. Offering Tongba is a symbol of respect to a guest among the Limbu people and also an important drink for special occasions and festivals Tongba is the vessel that holds the special drinks made of millet. These vessels are made up of wood or big bamboo and are in cylindrical shapes having a circular base on both sides. There is one side opened and another side closed, it is two-fit high and has a half-fit diameter. Also, a bamboo pipe in a cylindrical shape is used to drink. Tongba is of different sizes and their capacity varies with their size. For instance,one kuret sized whole and one-hand height. Tumba of bamboo generally contains one pathi liquid. Similarly, one bitta sized hole and one-hand height Tumba of bamboo contain 1.5 pathi liquid or one pathi and four manas liquid. Also, the drink we keep is made by special skill and mathematical calculation. To give the concept of circle and cylinder for the primary level mathematics students this vessel can be the best instructional materials.

Mathematics in Perungo. Perungo is a specially designed basket made of bamboo. It is elliptical and it is made by knitting small pieces of bamboo with each other. It has great importance in the Limbu community. Limbus use Perungo for storing foods for a long time as they believe that food stored in Perungo remained undamaged for a long time. It has great cultural value too in the Limbu community. Perungo is used by Limbu as the bag to carry gifts (Koseli) during marriage and other occasions. This bamboo-made basket is prepared by knitting small pieces of bamboo with each other with making regular hexagonal and triangular holes. So, it gives the concept of geometrical shapes. Also, being elliptic shape can be the instructional material for teaching conic sections too. In the same way, it gives the concept of the perpendicular and parallel lines too.

Mathematics in Nanglo. Nango has great significance not only in the Limbu culture even widely used in the diverse community of Nepal. Nanglo is used to separate the stone from the grains like maize, rice barley etc. It is a beautiful bamboo work in a circular shape. The concept of perpendicular line and the parallel line is used for its construction. Also, in Nanglo we can see many mathematical concepts such as quadrants, parallel lines, perpendicular lines, quadrilaterals, circles. The small pieces of bamboo are parallel, vertical pieces and horizontal pieces of bamboo are perpendicular lines in each other. Some pieces make parallelogram and the whole Nanglo is Circular in shape. Therefore, these objects help us to teach the basic concepts of the circle, parallelogram, parallel line, perpendicular line at the school level mathematics class.

Mathematics in Doko. Doko is a kind of basket made from dry bamboo strips. This artifact is an integral part of a farmer's life. It is especially used to carry goods like grasses, animal dung, firewood, grains, vegetables, water pots, etc., and even daily-used materials from the market to homes where there is no facility for transportation. It is also the means of transportation in a remote area as it is used to carry sick and old people. Also, it is used as a temporary cage for the animals.

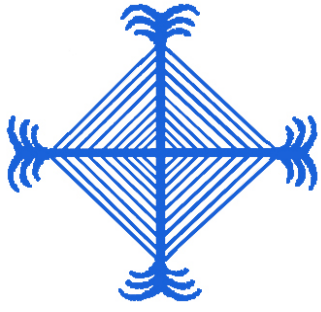
Doko is conical or v-shaped. Doko is generally 0.1 to 0.2 m^3 in volume, and it has a capacity of 20- 50 kg. Generally, its height is 2 ft. It has a rectangular or square base which expanded the ending with the wide end. Special art is needed to make Doko. The bamboos are cut into small long pieces which are called Choya. These Choya are weaved and Doko is made up. It is very famous in the Limbu community. Some people are taking it as the means of earning where can they weave Doko and sell in the market. If we see mathematically we can see the mathematical ideas hidden inside it. It contains different geometrical shapes like lines, curves, triangles, parallel lines, hexagons, polygons. Since Doko is very common in every Limbu's house in the village area.So, presentingDoko in the mathematics classroom to teach this concept might be the better idea.

Mathematics in Gundri. Gundri is a very common word in the village area of Nepal. It is used as a sleeping bed, sitting mat, and for drying pulses and grain. It is made of straw. It is rectangular. Gundri is common in the countryside of Nepal. After the paddy harvest during October and November, the long and flexible rice straws are separated to make Gundry. A-frame in a rectangular shape is made using rope and wood. Similarly, a plank of wood in a rectangular shape with holes in it is used to fix it. The rope frame is called the ta an and the rectangular wood is called the Hataso where Hataso is the rectangular frame wood.Gundri can provide the mathematical concepts like rectangle, parallel line, and circle.

Khungi. Kungi is a bamboo basket specially designed to put the hens in the Limbu community. This basket has a square base and a closed neck with a narrow mouth. It also has a cover that is too made of bamboo. Khungi is used for keeping the hens and chicks. Rearing chickens for meat, eggs and another purpose is most common in the Limbu Community. They do make the special house (Khor) for hens but in some cases, they use Khungi to keep the chicken temporarily. Especially it is used to keep newborn chicks. Alike Doko, Perungo, and Nanglo this bamboo-made basket (Kungi) also contain a lot of mathematical objects if we see through mathematical eyes. We can get the concept of a geometrical plane figure like Hexagon, Triangle, and it also gives the concept of intersecting lines, parallel lines, and curved lines, and cross section of three dimensional objects.

Wine (Rakshi Traditional drink). Wine (Rakshi) is the most famous traditional drink among the ethnic group of Nepal. Rakshi is the most integral part of the Limbu community. All short of celebrations and functions like marriage, festivals are incomplete without Raksi in the Limbu community. Even in the funeral rites, Raksi is mostly consumed in this community. Raksi is made from different food crops like paddy, maize, barley, wheat, millet, etc. most commonly millet is used for making Raksi in the Limbu community. First of all, the millet (Kodo) is cooked with water in the ratio of 2:3 and 1:3 respectively. After that millet is dried and is mixed with marcha and kept inside an airtight vessel for 12-13 days. Then after 12-13 days, the millet is cooked with water and by the process of condensation, the water vapor is changed to liquid which is pure alcohol.

To sum up, the vessels used for making Raksi give the concept of geometrical solids cylinder, cone and the geometrical plane figures circle triangle whereas the concepts of ratio and proportion can be taught from the above procedure of preparing while preparing alcohol (Raksi).



SilamSakma.*"Silam-Sakma*" is the name of the symbol/logo that identifies the Limbu tribal community. It means stopping the path of death. This symbol is diamond in shape and has nine concentric diamond shapes supported by two axes at the center, one vertically and one horizontally. In the Limbu community, Silam Sakma is given as a token of love to the guests and visitors. It is believed that Silam Sakma is given to the guest and relatives because it will protect and save us from Bad-things and give us good fortune. It is considered as the identity of the Limbu community and now a day this symbol is used in individual houses or any kind of organization of the Limbu people. In the pooja or any kind of function, a bamboo-made Silam Sakma is used as the main holy material in the Limbu community. Generally, the Limbus wear the thread made up from Silam Sakma as the batch in their dress as well. It is believed that Silam Sakma consists of nine squares or

rhombus starting from the smallest one to the biggest one with unique own meaning. If we gaze from mathematical eyes we can find Silam Sakma consists of different mathematical concepts like square, rhombus, parallelogram, perpendicular lines, parallel lines, point of intersection, supplementary angle, curved line, straight line, complementary angles, and so on. Therefore, if considered can be the instructional materials for basic level mathematics.

Ornament. Limbu women are famed for their use of gold jewelry and put by them daily with pride. They wear ornament made of gold, silver, and different kind of stones. Gold is called Samyang in their language and silver is called Yuppa. Most Limbu ornaments are inspired by the nature. It is said that Limbus has a very long history from the very beginning of their civilization Limbus were crazy regarding ornaments. They used to make ornaments from flowers, leaves, fruits, etc. Later on, after the discovery of gold and silver (Samyang and Yuppa) Limbu people started wearing gold and silver ornaments. Nowadays, traditional Limbu ornaments are used by different ethnic groups and can be found in other parts of Nepal too.

The traditional ornament of any locality reflects the identity of that culture. Limbu are mostly famous for their beautiful and traditional ornaments.

Some of the traditional ornaments of Limbu are

Samyangphung	Sesephung	Dhungri	Naugedi	kandhungri	Mundri
Kanthi	Chandrahar	Hukbanggi	yarling	Nesse (Chyapte sun)	Jantar

Samyamphung. Samyangphung is a Limbu ornament worn by women. Samyangphung means the gold flower where Samyang is the Limbu word of gold and phung is the Limbu word of the flower. This ornament is an important part of the Limbu attire. It is made of gold and a special kind of stone is inserted in the middle. This ornament is worn in the head on the front side just above the forehead. Special kinds of design are printed in this gold ornament. It is in the shape of a circular disc. This ornament can be the perfect instructional material for teaching circles. As it contains all the concept of circle i.e. Centre, the circumference of the circle.

Sesephung. Sesephung is the beautiful traditional Limbu ornament that Limbu women wear on their foreheads. Sesephung means bright flower. It is a forehead piece with a coral moon. A Limbu woman especially wears this ornament as the bridal ornament and also to fulfill their Limbu look with their Limbu attire while attending any kind of Limbu functions. Through our mathematical eyes, we can see mathematical concepts hidden inside it like curved line, point and so on.

Dhungri. The ornament of gold which is worn in the center of the ear is called dhungri. They are usually made up of gold. They are medium size around two cm in diameter and held in place by a long tube and fastened in the back. The design of Dhungri is usually starred with an uneven number of points varying from seven to eleven or flowers. It is also decorated with different flowers and different precious stones on it. These beautiful ornaments have the mathematical concept hidden inside them. It has the concept of circle, perpendicular line, center point. So, it can be taken as good instructional material in the mathematics classroom.

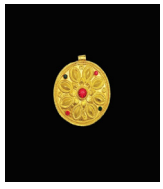
Jantar. Jantar is one of the traditional Limbu ornament especially worn by married women. This ornament is made of gold or silver and attached some precious stone to it. Earlier it used to come in a square shape with a different animal print like fish, butterfly, etc which is supposed to be a symbol of good luck. Whereas these days it is found in different shapes like rhombus, Hexagon, rectangle, square, circle, and so on. It is attached with Potee, or Naugedi, and is worn in a neck. It was also used to worn by the women to be safe from evil eyes earlier but by the time people wear it as an ornament in different functions whereas villagers wear it more often. This attractive ornament can be a good example for teaching geometrical shapes to the students who often see their mother wearing this.


Rhombus


Hexagon


Rectangle


Square

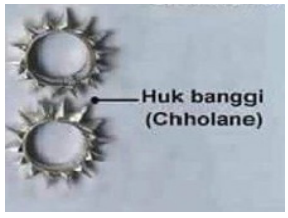

Circle

Namloyee or Yogakpa. Large silver necklace in the shape of a square or circle embedded with coral stones, same as Tibetan Ghau. It is the traditional Limbu ornament which is made of silver. It is well known for its unique design. It is very heavy and worn around the neck. It has a very beautiful and heavy locket in the square or the rectangle shape. A very beautiful stone is inserted in the middle of the locket. Also, the lockets are hanged in very beautifully designed silver plates. This ornament is very famous among the Limbu women. Both the married and unmarried women wear it on any kind of occasion or festival. If noticed mathematically this neckwear also contains mathematical concepts i.e. the concept of geometrical shapes like square and rectangle, lines and circle.

Nesse. Nesse is another traditional ornament of Limbu woman. It is the large circular flattened gold earring. It is also called Chyapte sun. The word "Nesse" is the combination of two words "ne" and "se" where "ne" is the short form of "Nekho" which means ear according to the Limbu language. Similarly, "se "means to bulge *(*to stick out in a round shape).

Generally, it has a diameter of 6 cm and a weight of 22.7 grams. Since it is like a circular disc and is worn around the ear its name is Nesse. Nesse is a very common ornament for the Limbu women. So, this ornament can be one of the best instructional materials for teaching geometrical concepts like circles, curved lines, etc.

Hukbanggi. Hukbanggi is a very beautiful Limbu ornament. It is also called Chholane. This ornament is made of silver. It is a kind of bangle. It is round in shape and has a thrown-like design facing outer parts. This bangle is quite heavier and Limbu women wear it with grace. Also, a mathematical eye that this traditional bangle can display the geometrical concepts like the circle, curved line, etc.



Yangyichi or Reji. Yangyichi or Reji is an old ethnic Limbu ornament that is long with coins. This necklace contains around 200 silver coins. It is worn by both married and unmarried Limbu women. This long necklace contains the numbers of the coin in round shape so it can be used in the mathematical class to give students the concept of the circle and it makes the students familiar with coins as well.

These are some sample artifacts that are mostly used in Limbu community. There are so many artifacts around the globe with mathematical nature and identity that can be used in the classroom praxis according as the local access for better understanding.

Conclusions

Ethnomathematics refers to a cluster of ideas concerning the history of mathematics, the cultural roots of mathematics, the implicit mathematics in everyday settings, and mathematics education. Moreover, Ethnomathematics is a field of knowledge that studies cultural,social, and political dimensions of mathematics education together with the natural indigenous setting of social practices. Hence the study of culturally related learning styles, historical developments in mathematics, and technology, prominent people in various cultural contexts who have made contributions to the field of mathematics, cultural applications of ‘non-traditional mathematics, and various forms of mathematics that draw upon the interests, abilities, and talents of teachers and students. It is necessary to blend the local practices,and uncovers the hidden original mathematical ideas in the classroom platform together with the enculturation of the nature of the society. This can shrink the colonizing and ready made modern abstract idea of mathematics for the emancipation of taken-for-granted ideas to challenge the status quo and significantly reduce anxiety among the mathematics students. This happens only when, we officially integrate indigenous cultural native knowledge through implanting in curriculum and policy making as the integrated factor of social phenomena.

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