

Chapter I

Introduction

Background of the Study

Mathematics is the study of quantity, structure, space, numbers and science and it developed with abstraction and logical reasoning from counting, calculation, measurement and from the study of shapes and motions of physical objectives. Mathematics began with the human civilization and practice. In ancient period mathematics was originated from counting by using pieces of stones and by cutting notches in a piece of sticks or by tying knots in a string with gradual evolution of society (Eves, 1981).

The concept of mathematics had begun from the very beginning of the human civilization. The gradual development of mathematics took place (Lamichhane, 2016). The beginning of human history, every culture has developed its own mathematical ideas and different practices. In some cases, these ideals and practices have been transmitted and diffuse from one culture to another (Orey and Rosa). From above both represents mathematics develop even in the development of human race and with the different kinds of works. It concluded that different culture have different mathematical ideas of mathematical concepts and have mathematical knowledge and it had been using from the different works.

Development of mathematical concepts is a major achievement of human civilization. Astrology, structural design, oceans, measurement system, economic planning and transaction are some of the areas, which need the use of developed mathematical concepts and reasoning. Developments in this field had started in early periods of history in china, India and the mediterranean modern endeavors at scientific investigations and technological advancements cannot be through of isolation, i.e. without mathematics. Mathematics may be considered a special kind of language developed to convey quality, shape, position etc. and their interrelationships. Its use is determined by rules of logic-the logic that emanates from the law of nature (CERRID, 1990).

The development and meaning of 'ethno-mathematics is the term 'ethno-mathematics' was introduced by the Brazilian educator and mathematician Ubiratan D'Amboise in 1977 during a presentation for the Association for the Advancement of science. Since D'Amboise put forth the term, people D'Amboise included have struggled with its meaning. Below is a sampling of some of the definitions of ethno-mathematics propose between 1985 and 1998? "The mathematics which is practiced among identifiable cultural groups such as national tribe societies, labor groups, children of certain age brackets and professional classes (D' Ambrosia, 1985).

From above the discussion, we can say that Mathematics is a creation from any culture.

Introduction of the Rai Community. The Rai, also known as the Khambu, is one of Nepal's most ancient indigenous ethno linguistic groups. The Rai belongs to the Kirat group of the Kirat confederation that includes the Limbu and the Sunuwar ethnic groups. The traditional homeland of the Rai extends across the Solukhumbu, Okhaldhunga (home of the Bahing, Wambule), Khotang (home of the Dumi, and Chamling), Bhojpur(home of the Bantawa). The Solukhumbu (home of the Thulung) and the Udayapur districts in the northeastern mountains of Nepal, west of the Arun river in the sun Koshiriver. Rais are also found in the Indian state of Sikkim and in the northern west Bengal towns of Kalinpong and Darjeeling.(Rai,2011)

According to National Population and Housing Census 2011, there are 620,004 ethnic Rai in Nepal which is represents 2.3% of the total population. Of this number, 70.89 % declared themselves as practicing the traditional Kirati religion and 25% declared themselves as Hindu and some Rai peoples declared themselves as a Christian. The Rai people are divided into many different sub-gropus, including the Hangkhim, Bantawa, Sotang, Chamling, Sampang, Yayokhya, Dumi, Jerung, Kulung, Khaling, Dilpali, Shamsuhaang, Lohorong, Mewahang, Rekhali, Thulung, Tamla, Tilung, Wahaling, Wambule, Parali, Yamphu, Jero, Puma, Syangbo, Sunuwar, Nachhiring, and Dewas. Some groups number only a few hundred members.

Statement of the Problem

There are so many people are from a different culture in Nepal. Nepal is a multi-lingual, multicultural, multi-religious country with 2.6 billion population of 125 ethnic groups and their 123 mother languages (National population Census, 2011). And also there are different background socially, economically, culturally, religiously and their have own language own rule and regulation. Generally, students are unsuccesses in mathematics subject at school level. If they are a success then they get a small score in math. Especially mathematical knowledge developed from European culture so I am going to Rai culture in Nepal. What are the indigenous knowledge of mathematics in the Rai community and what are the geometrical concepts practices in Rai Community and how to linkage with curriculum content that would help to easily understand to students.

And there so many Geometrical knowledge which is hidden from our curriculum content and try out this hidden mathematical knowledge in our mathematical knowledge in our curriculum content in primary level's formal education. This research would help to adjust different cultural background students. This study focus on indigenous knowledge of mathematics (especially geometrical part) of Rai community of Bhojpur district. Therefore, I would like to study in this field. Therefore the purposed research in concerned on seeing answer to the following research questions:

- What kind of basic geometrical concepts were practiced by Rai community?
- How can their geometrical concepts be linked with teaching learning geometry?

Objectives of the Study

The major objectives of this study were to explore the ethno-mathematics practices of Rai community at Bhojpur District. To reach this focal mission the following specific objectives were considered.

- To identify the basic geometrical concepts practiced by Rai community.
- To suggest the pedagogical implications of mathematical practices in Rai culture.

Significance of the Study

This study reflects and represents the indigenous mathematical knowledge practiced in Rai community. This study will be helpful for mathematics teacher, researcher, educators, students, mathematicians as well. Besides these, this study helps those people who are interested to understand the artifact of Rai culture. This study provides sound knowledge about what are the grammatical knowledge practiced in Rai community and how they are connected with formal education system at school level curriculum. Ethno mathematics is the systematic study which gives clear direction to understand mathematical knowledge related to particular ethnic community would be the greatest significant of this study. The significance of this study were as follows.

- This study explored the ethno-mathematical practices in Rai community, which is valuable and significant for further researchers to explain the knowledge of the mathematics of Rai community.
- This study would be helpful for the teacher to linked or connect the day-to-day classroom practices with a mathematics of Rai community which increase student understand.
- This study would provide knowledge about cultural geometry related to school geometry with its pedagogical implications used by Rai community.

- This study may help to promote explore mathematical knowledge and skill of the Rai community.
- This study would provide different kinds of local teaching objects, teaching methods, which is low cost and locally available.
- This study would help to remove geometrical anxiety, practicing multicultural curriculum, as well as the students, develop the habit to research geometrical knowledge surrounding them and daily-applied knowledge.

Delimitation of the Study

Delimitation of this study were as follows:

- This study was based on ethno-mathematical concepts in Rai Community of Bhojpur district.
- The sample of the study was indigenous people of 15 Rai.
- This study was based on only Rai ethnic group.
- This study was based on qualitative design.

Operational of Key Terms

Some terms related to this study were define and explain with contextual understanding as follows.

Ethnic Group.In Nepal, there are many kinds group of people with their culture, norms and values. A category people who identify with each other based on common ancestral, society, culture or nation who share a common cultural background, which is Rai caste.

Literacy.According to (National Education System Plan) NESP (1971), literacy means being able to at least read and write General Nepali and perform fundamental mathematical operations in daily life.

Ethno-mathematics.The study of interrelationship between math and culture. There are so many mathematical knowledge in culture so this mathematical knowledge linked with curriculum that is ethno-, mathematics.

Basic geometrical concepts.The geometrical concepts, which are used in everyday life, are taken as basic geometrical concepts for example Euclidean geometry.

School mathematical knowledge.In my study school mathematical knowledge means the knowledge of triangle, square, rectangle, straight lines, right angles, etc which is exactly related to formal education.

Mother language based education.In this study mother language, based education is that education which has been learning from mother from the very small childhood.

Culture.In my study culture, means a limit area there are many people living who have their own language, rule, norms, values who share common things.

Chapter II

Review of Related Literature

In this section, I have described the literature related to these two types of review; empirical and theoretical. A literature review is an important source of the further research study. It helps to researcher to have better perspectives and essential for guidance of the research plan. Some reviewed literatures related to my study are described below.

Empirical Literature

According to Lama (2016) research out on "Geometrical knowledge practiced in Tamangcommunity". The main purpose of this study was to explore the ethno-mathematical practices of geometry in Tamang community. He had used qualitative research design with ethnography approach. He selected 18 Tamang people from Lurpung village. He found that the geographical knowledge is strongly embedded in socio-cultural activities of the Tamang community and Tamang people measured length and breadth by using their hands and fingers like as: Ammal, Kuret, Bitta, Pit, Haat are the measuring units of length and breadth and the Kosh is the measuring right units of distance.

Similarly, K.C. (2008) has carried out research on "Basic mathematical concepts and processes ofPaharicommunity". The main purpose of this study was to find a document the counting system and carry out the measurement system practiced in Pahari community. His research was based on Pahari community at sathigharvagawatiV.D.C. of Kavrepalanchok district. He has used qualitative research design. He has selected 20 people from kavrepalanchok with purposive sampling for the study. He has used interview, observation to collect the data. This research has been founded the numeration system of Pahari is base 10. It seems that their

numeration system is same like as Hindu-Arabic numeration system. Pahari has no their own separate script. Therefore, there is no any specific symbol to represent the particular number.

Likewise, Karki(2008) has carried out research on "Basic mathematical concepts practiced by Hiyu community". The main objectives of this study to explore the counting system of Hayu community and to find out the rules of the four basic fundamental mathematical operations, measurement system used in Hayu community. He had used qualitative research design with ethnography approach. He had selected 10 people from DadiVDC with purposive sampling. He used observation, in-depth interview, photograph, data collection. He founded Hayu people have not their own script but have their own language and their own name for numbers one to one hundred. Hayu people solve their addition and subtraction for based on 20 and they used and fingers unit kuret, bitta and hat. They used kosh to measure long distance.

MoreoverMajhi(2018) has studied on the topic "Basic geometrical concepts practiced by Majhi Community". In this study, the main objectives of this study to explore the pedagogical implications of basic geometrical concepts practiced by Majhi community. The design of the study was qualitative in nature and ethnographic approach. He had selected Marin Village institution-6 of sindhuli district. He did purposive sampling method to select sample. He used the interview, observation, and photographs as a data collection tools and tried to find out real field data. Moreover, he found that a Majhi community was a source of geometrical knowledge they used it in their daily life activities.

In addition to this, Sherpa (2018) studied on the topic "mathematical concept and socio-cultural practices in Sherpa community base 10 and base 20 numeration system have been practiced in Sherpa community for counting process. Sherpa have no their own script. However, they have been following the Tibetan script. They measured length and breadth by using hands and fingers. Tha, Thu is the measuring units of length and breadth. Moreover, the Kosh is the measuring right units and distance. The units of volume measurement are Vhimti, Muthi, Chauthi, Mana, Kuruwa, Pathi and Muri. The units of weight measurement are Chhatak, Pau, Bisauli, Bhami, Aathpol, kg etc. He used qualitative ethnographic research design. He used interview and observation were adopted as data collection methods. His research was based on Sherpa community at BeniV.D.C. with a sample of 10 People.

Also, CERID (1990) research on " Elementary process of learning mathematical concepts and process of RasuwaTamang". The main purpose of this research was to study of the basic mathematical concepts used by Tamang adults with no formal mathematics education to identify traditional Tamang method of mathematics operation and to find out the implication Tamang processes and tone up the present learning situation. This research has that Tamang have their own system of measurement, counting, and their own Geometrical concepts and process are the base on the structure patterns and shapes of objects existing around this study has also

shown the situation of children into formal system but it did no study the effect of ethno- mathematical practices in the classroom settings.

Theoretical Review

In this chapter, I have reviewed some theories related to my study. There are various theories about learning mathematics, ethno –mathematics, constructivism and ethnography. Some reviews, which are presented below.

Constructivism.In constructivism there is no any knowledge that exists of the person, there is no objective reality. Knowledge must be actively constructed by learners as they are already "knowing beings" who bring previous knowledge and experience to any learning events (Acharya, 2015).

Lama (2016) Constructivist teaching based on the belief that learning occurs as learners are actively involved in a process of meaning and knowledge construction as opposed to passively receiving information, learners are the makers of meaning and knowledge, critical thinkers, motivators and independent learners. It holds that learning always builds on knowledge that a student already knows about prior knowledge is called schema because all learning is filtered through pre-existing schema, constructivists suggest that learning is more affected when a learner is actively engaged in the learning process rather than attempting to receive knowledge passively. A wide variety of methods claims to be based on constructivist learning theory. Most of these methods rely on some from guided discovery where the teacher avoids most direct instruction and attempts to lead the student through questions and activities to discover, discuss, appreciate and verbalize the new knowledge. There are a number of different forms of constructivism, but underpinning all version are three premises:

Knowledge is actively constructed by learners, learners reflect on their physical and mental actions with learner come to integrate new knowledge into their existing mathematical schema and learners come to construct a more robust understanding of mathematical concepts and processes through the process of negotiation, explanation, and justification.

Above the discussion, in postmodernism constructivist teaching is important for the learner. In constructivist, teaching students or learners get a chance actively thinking about the learning. This is a theory about learning, not a description of teaching. Constructivist theory is instructional techniques can be abstracted from the proposed as a constructivist approach to teaching and some general principles learning derived from constructivism may be helpful to keep mind, however, as we rethink and reform our educational practices.

Constructivism recognizes that mathematics must make sense to students if they are to retain and learn mathematics. For students to developed appropriate knowledge, they must be provided with rich learning experiences so that their

constructed meaning and understanding are in keeping with the discipline of mathematics (Ernest 1991 cited in Acharya, 2015)

Constructivism is a post-structuralist psychological theory (Doll, 1993), one that constitutes learning as an interpretive, recursive, nonlinear building process by active learners interacting with their surround-the physical and social world. It is a psychological theory that describes how structures, language, activity, and meaning making come about, rather than are that simply characterizes the structures and stages of thought, or one that isolates behaviors learned through reinforcement. The challenge for educators is to determine what this new paradigm brings to the practice of teaching. Behaviorist framework preplan a curriculum by breaking a content area (usually seen as a finite body of predetermined knowledge) into assumed component parts-"skills"-and then sequencing these parts into a hierarchy ranging from simple to more complex. Assumptions are made that observation, listening to explanations from teachers who communicate clearly, or engaging in experiences, activities, or practice sessions with feedback will result in learning; and that proficient skills will quantity to produce the whole, or more encompassing concept (Bloom, 1956; Gagne, 1965).

Social constructivism. Social constructivism emphasizes the importance of culture and context in understanding what occurs in society and constructing knowledge based on this understanding (Derry, 1999; McMahan, 1997). Similarly, according to social constructivism, knowledge is the best constructed when learners collaborate together (Lama, 2016). This shows that social construction belief on the multiple constructions of the world. To understand and apply models of instruction that are rooted in the perspectives of social constructivists, it is important to know the premises that under them.

Kim, B. (2001) says:

"Historical developments inherited by the learner as a member of a particular culture. Symbol systems, such as language, logic, and mathematical systems, are learned throughout the learner's life. These symbol systems dictate how and what is learned. The nature of the learner's social interaction with knowledgeable members of the society is important. Without social interaction with more knowledgeable others, it is impossible to acquire the social meaning of important symbol systems and learn how to use them. Young children develop their thinking abilities by interacting with adults"

Vygotsky's general genetic law of cultural development states: Any function in the child's cultural development appears twice of no two planes. First, it appears on a social plane, and then on the psychological plane. First it appears between people as an interpsychological category, and then within the child as an interpsychological category Social relations of relations among people genetically underline all higher functions and their relationships. The natural, lower, biologically based, psychological functions are transformed into higher mental processes because of

intrapsychic functions undergoing interiorization wherein they are wedded to the lower functions and transform them into the higher intrapsychic functions. In other words, the higher psychological functions were first external, social, involving interpersonal relations before becoming internal psychological processes (Vygotsky, 1929/1989).

“Sociogenesis”, Vygotsky affirmed, “is the key to higher behavior” (1929/1989, p. 63). All that is internal in the higher functions was of necessity external at some point; it was social, a relation that was between two people, before it became an individual function. This idea achieved its fullest expression in Vygotsky’s general genetic law of cultural development. Vygotski (1934/1963) expressed the law as follows: All higher mental functions make their appearance in the course of child development twice: first, in collective activity, social activity, i.e. as interpsychic functions, second in individual activity, as internal properties of the child’s thinking, i.e. as intrapsychic functions. In social constructivism, the main three things which are presented below.

Making meaning. Learner makes process, understand or make sense of life events, relationships, and the self. Learners built up any things meaning from the society, which is the important role of society in learning.

Tools for cognitive Development. In society there are so many tools for the learners that are culture, ancestors, senior parents, Language are the tools of knowledge from them a learner can get a lot of knowledge in learning their mobilization and their natural towards education affects the learning.

The Zone of Proximal Development (ZPD). ZPD means different between the actual development levels as determined by the independent problem solving and level of potential development as determined through problem solving under MKO (More Knowledgeable Other) and solving problem from the supporters of Others. In ZPD provide scaffolding – masters task remove (fading) · Social interaction leads to increased knowledge. The development of ZPD with the relevance of social guidance, collaboration, and social interaction.

Conceptual Framework for the Study

A conceptual framework was formed different factors is a type of theory that attempts to connect all aspects of inquiry such as mother language-based education, school mathematical knowledge, theories, geometrical knowledge practice in Rai

community and mathematical knowledge in school level, data collection, and analysis with the propose of systematic study on ethno-geometry. The connect of mother tongue-based education and geometrical practices of the Rai community would encourage to research on ethno –geometry.



Source: Karki(2017) and Lama(2016).

Geometrical knowledge practices in the Rai community would help to implement mother tongue-based education in school level by making aware the community. The following is the framework for this research.

The conceptual framework devised through the literature studies facilitated to attain research objectives, get the answer of the research questions and carry out the research work as a whole smoothly (Acharya, 2015). In the above figure Rai Geometrical knowledge practices is the main issue in this study. This framework is linking between school mathematical knowledge and geometrical knowledge practices in Rai community. At last all factors linked with mathematical knowledge in school curriculum course implies that to formulate new curriculum. We must know of ethnic group and different theories and current mathematics curriculum.

Chapter III

Research Methods and Procedure

In this chapter, the research design, methods procedures, study site, sample of the study, tools of data collection, data collection procedure, data analysis and interpretation are discussed below.

Design of the Study

This qualitative research design is a research method used extensively by scientists and researchers studying human behavior, opinions, themes and motivations. According to Creswell (2004), there are five different types of qualitative research, which are phenomenology, grounded theory, ethnography, narrative inquiry, action research and case study. My research design was ethnography in nature because it helped me for systematic and scientific study of socio-culture of the Rai community. So qualitative research methodology guided me to click and every moments of in my study. "Qualitative research is multi method in focus, involving an interpretative, naturalistic approach to its subject matter" (Creswell, 2004). This means, it was helped me to reach natural socio-cultural activities of the community by using multi-cultural methods where it was concerned with people's belief, lives experience and context of particular time.

Study Site

Rai people are mainly found in eastern districts of Nepal like Bhojpur, Khotang, Kolukhumbu, Sankhuwasabha etc. Among them Bhojpur District is also known as the local residence of Rai people. There are number of cultural heritages of Rai people. Therefore, my research was in Bhojpur district of Nepal.

Selection of Respondents

This study was based on qualitative research. So the sample size of this study was 15 Rai people. At first four villages named Lumma, Wachha, Papungga and Pokhare were selected with purposeful samples and then respondents were also chosen by the purpose sampling. I selected five Rai people from Lumma and among them one was artifact maker, two were senior Rai people and two were housewives. I selected five people from Wachha and from them one artifact maker, two were farmers and two were senior educators. I selected three people from papungga village from them one senior Rai ancestor, one farmer and one housewife. Finally I selected two people from Pokhare village from them one was a house maker and carpenter and another was social activist and cultural rituals man. I discussed with other senior Rai people as needed for my research study.

Instruments

There are many methods in qualitative research, which have different kinds of procedures to get information during the research. In this research adopted interview, observation, and photograph of different objects to get answer the research question which are described below.

Observation Guidelines

To collect the information, the observation is one of the most important techniques in the qualitative research. I visited directly and indirectly around the study area to know the villagers cultures their daily life activities (agricultures, construction process of domestic object and other specific activities), experiences, geometrical concepts and environment. I collected and categorized those objects, which gave the basic geometrical concepts and I took photos of that objects while making field note. I used both the participant and non-participant observation for the study. In this research I noted the mathematical (special Geometrical) concept to select narrative peoples. Observation helped to get information, which was not obtained from interviews. Observation was helped in finding the answer of different kind of questions like, what are the geometrical figure or concepts they use in their occupation?, How do they work?, how does socio-culture context effect? How do they think about mathematics?

In addition, I was concentrating on the practices that are related with geometrical knowledge practice. Observation gave the information about the contextual interview guidelines. After all the observations, I identified their basic geometrical concepts and its pedagogical implication.

In-depth Interview Guidelines

Interview is the process of data collection from face to face interaction with respondents. Interview is the two way interaction between interviewer and interviewee in which interviewer creates situations that can attract the attention of respondents for an enough period of time in asking questions and answering the questions which interviewee puts his/her understanding and meaning (Karki, 2017).

At first, I prepared interview guidelines including open-ended topics based on research document, objectives of the study, suggestion from my supervisor and according to the situation of environment. Then I met the Rai people individually. I made clear about my researcher propose of research and importance of their help. I had carried out the open-ended interview along with unstructured and structured questions as well as observation.

I took the in-depth interview with Rai farmers, Senior Rai people, Rai house makers, Rai housewife, Rai ancestral to collect primary data. The main objectives of the in-depth interview was to identify the basic geometrical concepts practiced by

Raicomunity and its pedagogical implication. I took interview about cultural artifactused in field and its construction process, cultural objects, cultural activities. At that time, I took photos, videos, voice records, audio records and made field note. The data from interviews consisted of direct questions to people about their skill, experiences, ideas, knowledge of geometrical concepts.

Data collection Procedure

First, I went in my village with tools (interview guidelines, observation guidelines, etc.) so that made me easy because that was my own village. I discussed with the Rai farmers, Rai leaders, senior adults, and senior educated person. There were five respondents in my village. I directly told my purpose of research to them because that was my own village. First, I took interview with farmer. After that I took interview with senior educatorand housewife. Similarly, I visited four villages for the of Bhojpur district. Sometimes I did work with them in the field and that time I asked them how to make these objects then they told me the construction process, and I recorded their voices what they told. At that time, I took photos and videos. In course of visiting the villages at and first I introduced myself and I did not tell my purposes but I told to them its my interest to find the geometrical knowledge of Rai community.I visited their work fields, houses, farms, schools, worshipping and celebrating festivals for the informations. At that time, I took photos with voice records and field note. I collected information as needed from respondents with the help of observations and interview.

Data Analysis and Interpretation Procedures

At first,I visited my village area and I measuredthe tools of data collection needed for my research study. I used unstructured interview and observation form. By using these tools, I made identification of geometrical concepts and its implication inour curriculum I asked research question to Rai farmers, teachers, students and senior educators as well. I took interview according to objectives of the study and at that time I marked audio and video records along with photos then I collected the necessary information.After finishing collection of information, I divided them in to different geometrical aspects. Then started coding the similar information from field note. After finishing this task, I categorized and kept the information under the different headings. Then I moved for my first objective to find the measurement system practiced in Rai community then I worked for second objective to explore the

way of using four fundamental operation in mathematics of Rai Culture. Lastly I workedover the last objective to suggest the pedagogical implication of mathematical practices in Rai culture.

Then I interpretedall the collected data with the help of different theories review, the literature review based on ethnography and case study of Creswell (2004). My research design was ethnography in nature because it helped me for systematic and scientific study of socio-culture of the Rai community. Similarly, I collected necessary data for this study. Then I read articles and thesis related to incorporating cultural practices to formal practices. Moreover, I tried to link these practices with formal education by observing the cultural practices.

Chapter IV

Analysis and Interpretation of Data

This is an ethnography study related to find mathematical concepts practiced in Rai community. The objectives of this study were to identify on the basis of geometrical concepts practiced by Rai community and to suggest the pedagogical implication of mathematical practices in Rai culture. There were fifteen respondents. I used observation guideline and in-depth interview along with photos, videos, audio records for instrument related to my topic "Basic geometrical concepts practiced by Rai community" and its pedagogical implication. Then I analyzed all the collected data by the help of different theories review, the literature review section and all collected data then I generated one theme. I read articles and thesis related to incorporating cultural practices in to formal practices.

I spent 30 days in my research field (case study), beginning of last March 23rd, 2019 to 23rd April at Shadananda municipality of Bhojpur district. In these days I observed the activities of the Rai people [senior Rai people, farmer, house wife, artifact]. I discussed with the senior Rai people, farmer, housewife, and artifact. I talked with Rai ancestors. This chapter has been divided into three parts such as measurement systems, fundamental operation system and different geometrical shapes in use, etc.

Thus, the obtained data were analyzed and interpreted under the following headings.

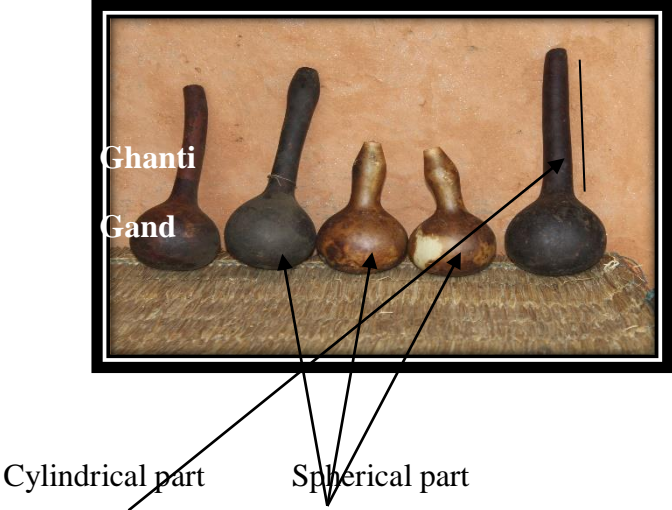
Activities Practiced by Rai People

There are many activities practiced by Rai people in their particular community. We can find different geometrical practices from those activities done in Rai community which are described and interpreted below.

Mathematics in Chindo and Solowa.Chindo is one of the most popular cultural object used in Rai community. They put Chhyangin these ojects in their festivals. The two senior senior respondnts from Rai people of this rearchreplied to me that shape of chindo and solowa. There are two part cylindrical shape and surface shape. It is a kind of fruits like a cucumber. We have to cut from the base side and clean this object.

According to the respondents

"Chindos contain one Mana because almost all Chindos have same and equal in size. The upper part of Chindo is called Ghanti and lower part of Chindo is called Gand. But Solowas have biggerGand in lower part and longer Ghanti in upper part than Chindos. So, that Solowas contain about One Sher (2 mana= 1 Sher) Jaadh of Raksi. If we measure clearly, one Kuret longer Solowa contains one Mana and 1.5 Kuret longer contains one Sher".



We can find the different types of basic geometrical concepts in this object, which are directly linked with school geometry. There are two parts that one part is surface and another part is cylindrical, so there is one base circle. If we use this object as a teaching object in the classroom to teach the concept of surface, cylinder and circle shape then the students can understand easily at the school level.

Mathematics in Preparing Tumba.Tumba is another famous object, which is used in Rai culture. It is used for eating chhyag(jaad). While doing this research, I observed my own community for the data collection. At that time, I asked some research questions to one of the Rai people about his concepts.

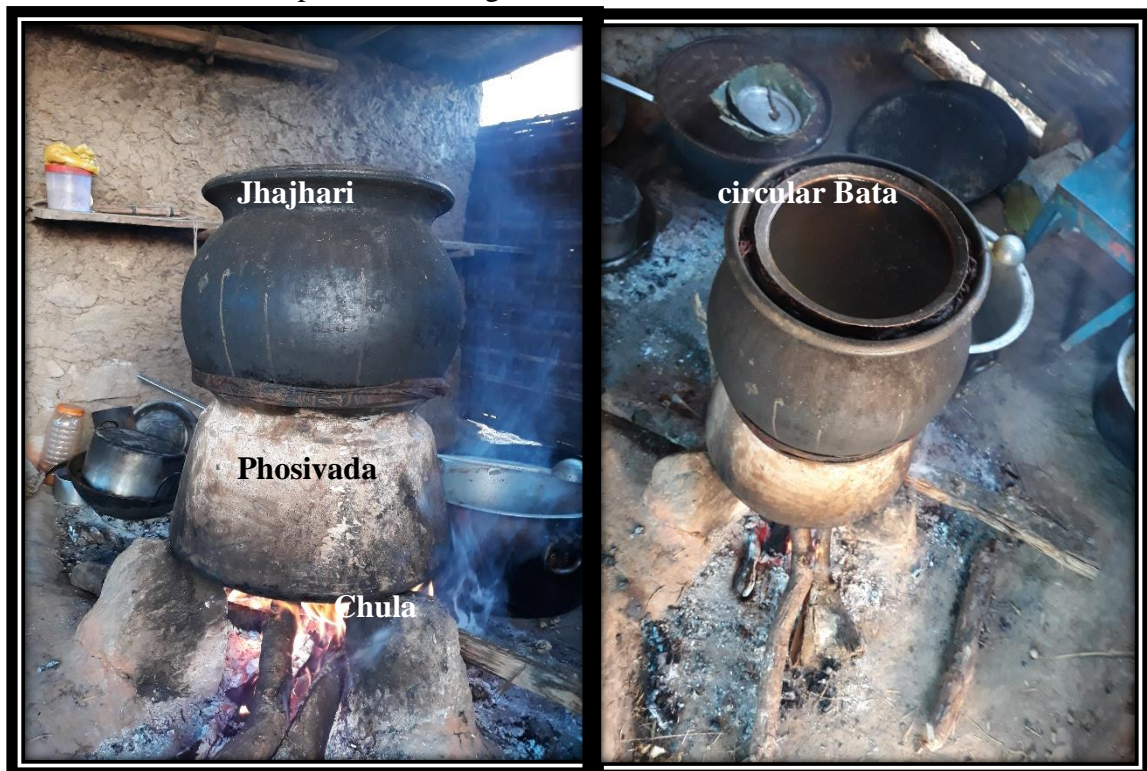


The respondents told me that

"Tumbais made of from big bamboo. There is one open side, another side is closed, which has two fit height, and half fit diameter. It is cylindrical in shape and there is circle in both sides. They cut bamboo and make these objects. According to the respondents, one kuret sized hole and one hand height Tumba of bamboo generally contains one pathi liquid. Similarly, one bitta sized hole and one hand height Tumba of bamboo contains 1.5 pathi liquid or one pathi and four manas liquid."

From this object, we can find the different types of basic geometrical concepts, which are directly linked with school geometry. There are two parts in which one part is circle and another part is cylindrical. So that if we use this object as a teaching object in the classroom while teaching the concept of cylinder and circle shapes then the students can understand easily at the school level.

Mathematics in Making Alcohol. First respondents told me about the process of making ale [chhyang or Jaad]. Jaad is very famous for a drink in Rai culture. At that time of field study, I had asked to my respondents about their ideas for making alcohol with the help of interview guidelines.



Then they replied that,

"At first, to make alcohol must put morcha, which is made offlour, rice and leaf of white Dudhi. While making ale which means Jaad of chhyang, we need to boil 1/3 water and 2/3 part of millet is cooked. After cooking this, we dried and mixed with 100 gmMorcha. Moreover we are kept in sack and finally in to the drum. After about five days, it will be converted in to ale which is called Jaad in my culture. Then after 10 days it will be ready to make alcohol (Raksi). Then we placed the pot on that Chula keeping with water and ale. Than we placed the Jhajari and put small pot into Jhajari which is called NaniHadi. Then they placed Bata on jhajari and put water into it. When the water is boiled then they replaced water by cold water similarly it is reiterated 6/7 times then alcohol is ready in Nanihadi".

Then I found that there was Chula, which was made of three stones in circular shape at every 120° angle to each other. There are circular shape, spherical shape, cone shape in Jhajari, Bata and phosivada. The concepts of ratio and proportion can be taught from the above procedure of preparing alcohol[Raksi].

Objects used in Rai Community

There are many objects found in Rai culture, which are related to geometrical knowledge that can be used as a teaching object for teaching different geometrical concepts which are described below.

Use of Mathematics in making Doko.Doko is a common artifact that we could see in Rai community. Doko is a kind of basket made by Bamboo. Dokos are usually in V shape but there is a square shape in base. We find different size of Dokos, generally half and 2 Ft. height and 1Ft. rectangle in base the increasing V shape from the base. According to the respondents

"Dokos are specially used to carry grass, firewood etc. if length is one bitta and breadth is one kuret in the base of Doko, then any size of Doko can be made as the Doko maker's wish. Five couples of choya are needed for one bitta length and four couples of choya are needed for one bitta breadth while making Doko". For e.g. $5 \times 4 = 9 \times 2 = 18$ pieces of choya.

Some geometrical concepts in Doko are given below.

- parallel lines
- Hexagons
- Straight line



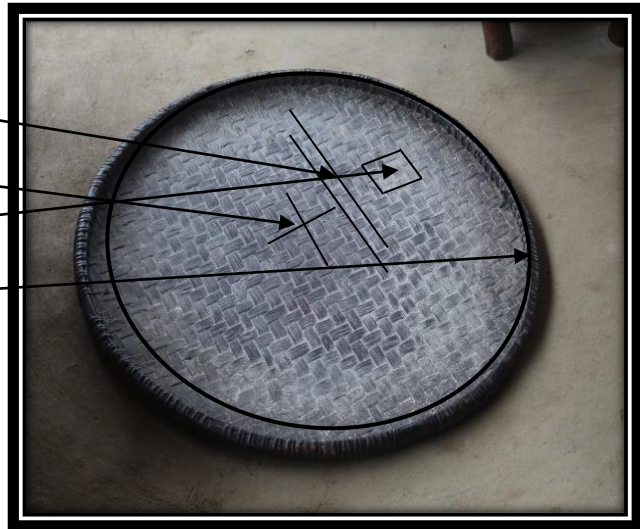
A single Doko carries several shapes like geometry, arithmetic, measurement, logic and reasoning. It is a combination of art and mathematical real concept that can be living context in the classroom teaching of lines, curves, triangles, parallel lines, hexagons, polygons. We can see that some triangles, hexagons [Each angle $\frac{(n-2) \times 180^\circ}{n}$ and sum of total interior angle $(n - 2) \times 180^\circ$], straight lines, parallel lines, curves in shape. So it can be used to teach the concepts of above at the school geometry if we consider it as a teaching object.

Mathematics in Nanglo. Nanglo is a very useful object in Rai culture.

According to the respondents

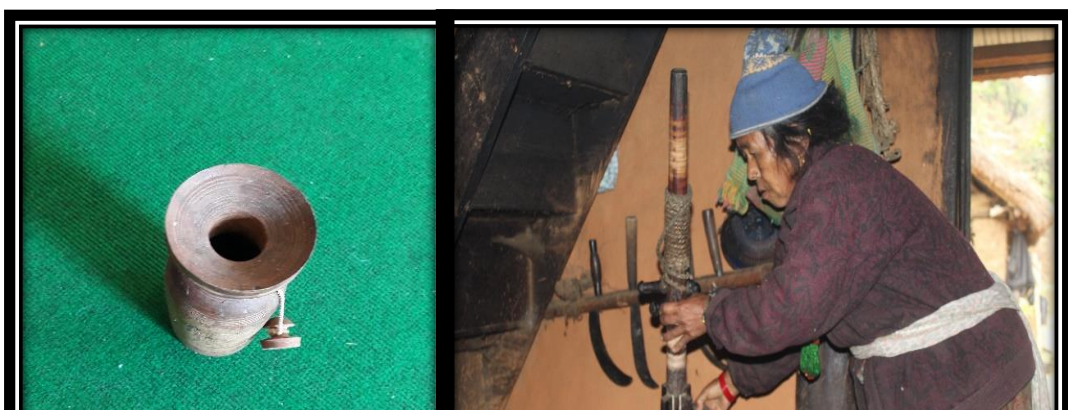
"Nanglo is used for making flour pure from the mixture of any other unwanted thing. It is used; pick poddy, cone, etc from the waste of stones. It made from small pieces of bamboo in the shape of circular. It is use the concept of parallel line, perpendicular line and then circular to construct it. First, choya is made from bamboo and the Nanglo is made. In Nanglo we can see so many mathematical concepts such as quadrants, parallel line, perpendicular lines, quadrilaterals, circle and Nanglo itself is in circle shape".

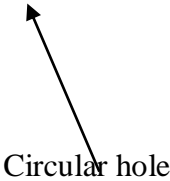
- Parallel lines
- Perpendicular
- Parallelogram
- circle



In Nanglo there are different types of geometrical concepts. The small pieces of bamboo are parallel, vertical pieces and horizontal pieces of bamboo are perpendicular lines in each other's. Some pieces make parallelogram and the whole Nanglo is Circular in shape. Therefore, these object help us to teach the basic concepts of circle, parallelogram, parallel line, perpendicular line at the school level in geometry class.

Mathematics in Theki and Kathuwa. The respondents of this study said that, *"They have been using Theki for making ghee, and it is used to store milk of cows and buffalos. They said that some kumal people make that Theki. It is made from jackfruit tree. And the kachuwa is same in shape but it is very small than Theki. It is used to put Raksi in marriage ceremony of Raiculture. In Theki and Kathuwa there are same mathematical concepts. They are a circle and cylindrical shape. There is another object for making ghee is called Madani. There is helix type rope, which helpsto spin Madani"*.



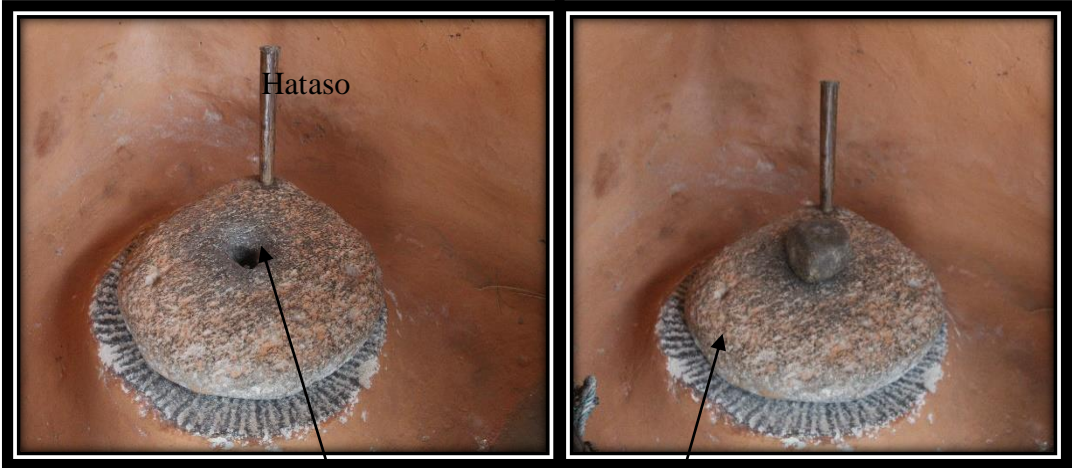


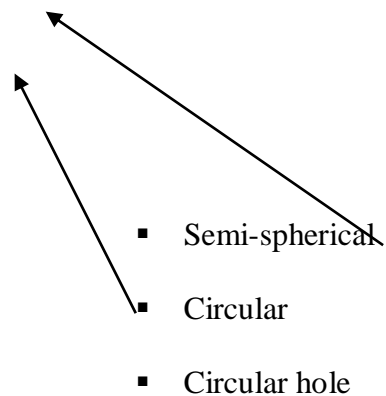
Thekis

In Theki and Kthuwathere are circular shapes and cylindrical shapes. These objects help us to teach the basic concepts of circle and cylinder. In madani there is a three dimensional concepts which are specially related to higher level. In madani there is helix concept so we give an example for helix by using Madani. If we give these kind of example in teaching learning activities then the students can learn easily and they memorize for a long time.

Mathematics in Janto.I asked the research questions to the respondents about this concepts of geometry which were used in Jantowith the help of interview guidelines. Then the respondents told me about theJanto,

"That is traditional machine constructed by hard stone. It is used for grinding grains there are two parts in Janto which has semi-spherical and circular shapes. In upper part of Janto, there is a cicular hole from where grains are dropped for grinding. Similarly, there are circular shape and semi-spherical shape in lower part of Janto".





The respondents said that,

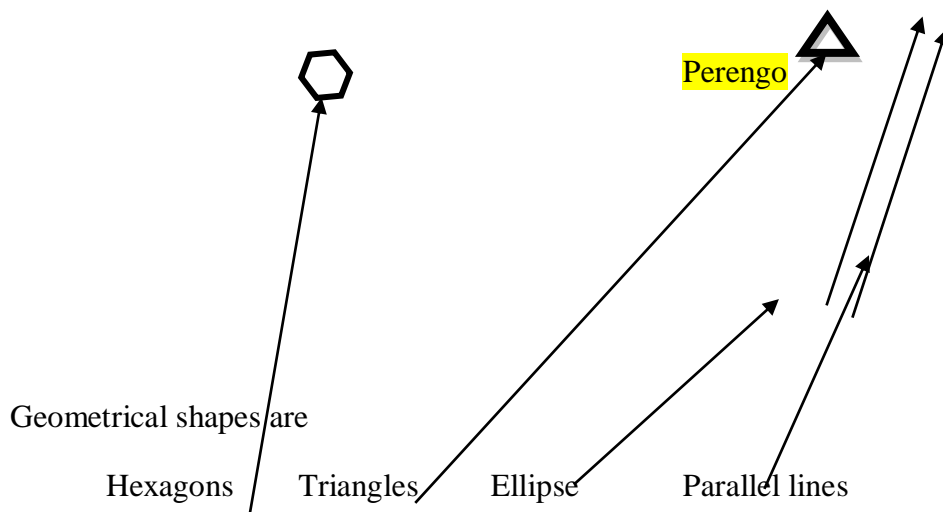
"Janto generally rolls from anticlockwise. There is a mani in the middle of lower part of Janto. While fixing a Mani, first of all we need to make a hole in the middle of lower part of Janto. Then a half part of small piece of iron is buried in the hole attaching with a piece of wood which is called Mani. A half part of Mani is fixed in one kuret above than the lower part of Janto. The stone of lower part of Janto is buried up to 1 inch below from the surface level of land. After that the lower part of Janto is covered with muddy and given perfect shape. There is a small hole in the upper part of Janto from where grains are dropped for grinding. The upper part of Janto is supported with Mani. Similarly, Hataso is fixed on the outer part of Janto which is used to move the Janto. When Janto is rounded rapidly then the grains are scattered everywhere but, when it is rounded slowly then the grains remain near the Janto".

In Janto there are circular shapes and semi-spherical shapes. These objects help us to teach the basic concepts of circle and sphere. In school level, we can teach circular shapes, semi-circular shape, and cylindrical shape from these objects.

Mathematics in Perengo. I talked to the respondents with my research questions then they told me that

"The shape of Perengo is an ellipse in shape which is used for keeping piglets, oranges and keeping dry fishes and meat. It is a kind of basket made by small pieces of bamboo by knitting each other with making regular hexagonal and triangular holes. After keeping objects or oranges, piglets, dry meat etc they tightened its mouth by using the rope of jute. They told that if we put dry fishes and meat then they cannot be damaged for long period of time".





We can find the different types of basic geometrical concepts in this object. The whole shape of this object is as an ellipse. There are some holes, which are regular hexagon, and some small triangles. So it can be used to teach the concepts of ellipse, regular hexagon, parallel lines, and different angles like opposite angles, corresponding angles, alternative interior angles. There are so many types of angles [internal angles of two parallel line, opposite angle, alternative angles, corresponding angles etc.], and triangles at the school geometry if we consider it as teaching objects.

Mathematics in Ghum. A respondent of this study replied to my research questions that,

"It was a kind of traditional domestic object of Rai community. The shape of this object is as a plane curve and constructed from small pieces of bamboo. It is used to protect the body from the rainfall and sunlight. Especially it is used in summer season while working in the field. I found that he used to make these object from the process of parallel lines, squares, triangles, and hexagonal holes as well. He made it in such a shape so that it covers all the body of human from rainfall and sunlight. There are two same size pieces and covered with same size of a plastic piece between two pieces of Ghum."

There are many geometrical concepts in Ghum.

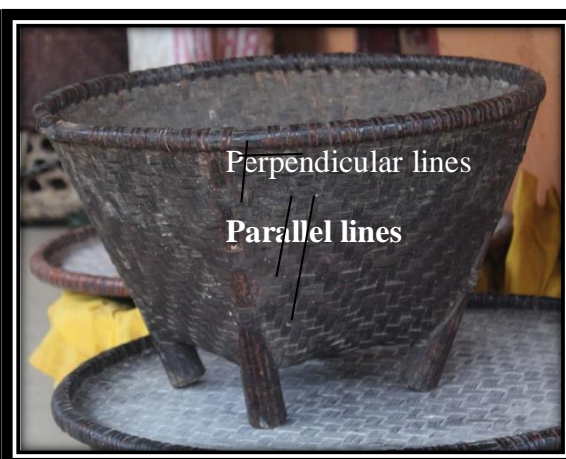
- Squares
- Hexagons
- Triangles
- Parallel and perpendicular lines
- Various types angles



There are different concepts of geometrical knowledge found in Ghum, which has direct link in school geometry. There are some small splits of bamboo that are parallel and some pieces are perpendicular to each other. There are different kinds of holes which are in squares shapes some are regular hexagons and some are triangles. As a whole, it is a plane curve in shape. Therefore, by using basic geometrical concepts of this object, we can teach the basic concepts of geometrical like as parallel lines, alternative angles, corresponding angles, interior angles, perpendicular lines, regular hexagons, triangles, squares and plane curves in school if we consider it as a teaching object.

Mathematics in Dalo. Dalo is a traditional object used in Rai community for different purposes. The respondents said that,

"Dalo is used for storing rice, paddy, corn, millet. It is made from small pieces of bamboo in the shape of cylinder. This is made from specially Sunuwar Rai people. At first, they used the process of parallel line, perpendicular line and rectangle and then folds circularly to construct it."



The geometrical concepts found in Ghum are,

- Perpendicular lines
- Parallel lines
- Circle
- Various angles between two straight lines or parallel lines

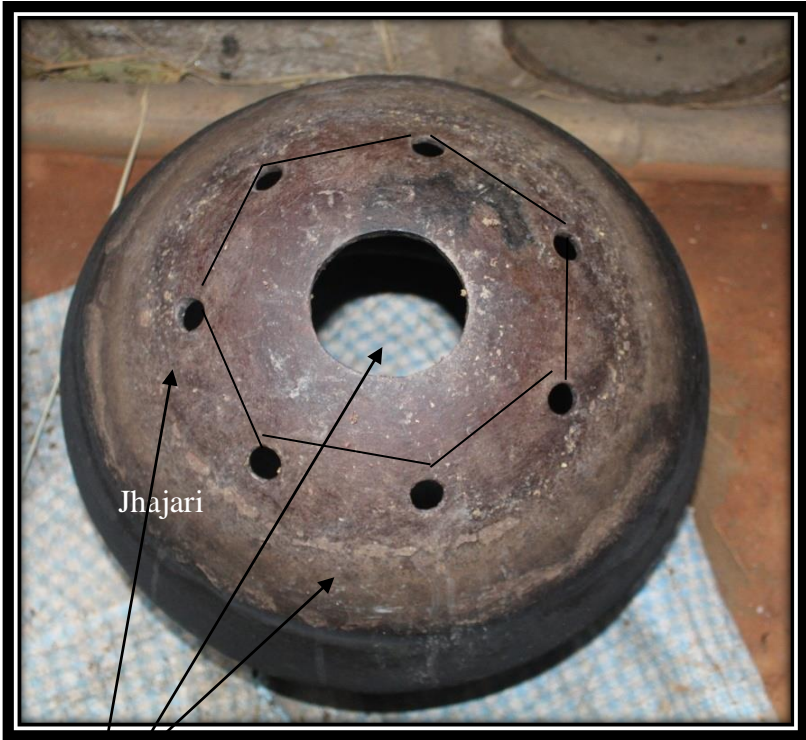
We can see circular hole in open side of this object. This object is considered as a perfect example to make clear the concept of parallel lines, circles and the angles between two straight lines at the school level. So if we use this object to teach the concept to students can understand easily.

In this process of making alcohol, different types of mathematical geometry concepts are found. In phosivada is circular shape and cylinder shape, in the process of making alcohol stones of Chula are arranged in circular shape at every 120° angle and all Chula are perpendicular to land. So by the observation of this process of making alcohol we can teach the basic concepts of sphere, circle, angle and perpendicular at the school level.

I knew that without mathematical knowledge the Rai female have this concept. They have no any formal knowledge, they were from no any formal education background but they are known about ratio, quantity, angles, shapes etc.

Mathematics in Jhajari. This is used only for making alcohol in Rai community. The respondents said

"This is made from cooked clay by Kumal people. It helps to pass out a vaporous of ale. Its weight is 3 / 4 k.g. there are many mathematical concepts of special geometrical shapes like circle, hexagon, non-Euclidean concepts. They told that jhajari is same in scale everywhere; it must be same size of phosivada so there are seven holes in base side of jhajari. If there is no same sized hole in equal distance then Raksi is not made well.so it happens".



The geometrical concepts found in Jhajari are,

- Sphere
- Circles
- Heptagon

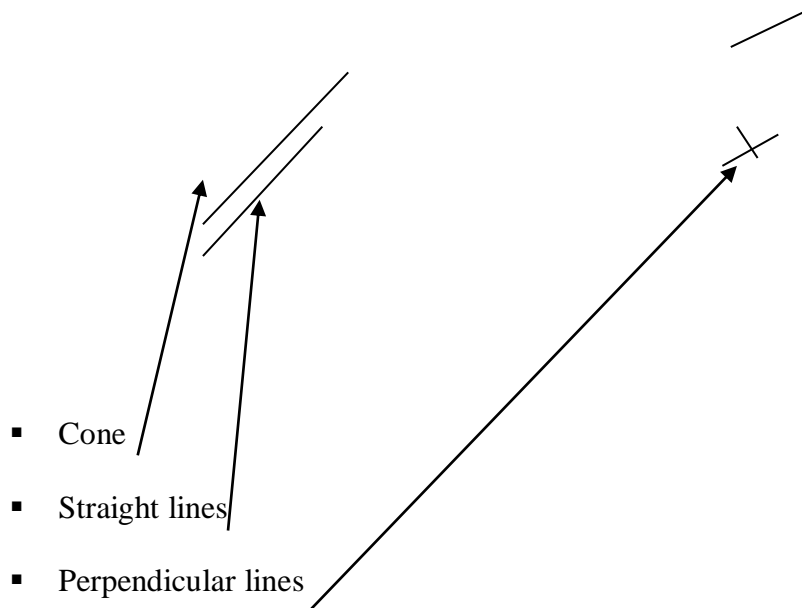
In this figure, there are many geometrical concepts, which are circles, sphere, and heptagon in shape [if we join by straight lines of these all seven holes]. It is possible that we can give an example of Jhajari in geometry class. If we teach this concept with counter example then the students can learn easily.

Mathematics in Chhapani. Chhapani is one of the important object in Rai community. There is 3-dimensional geometrical in shape. It is in cone shape.

According to the respondents,

"It is constructed by small pieces[choya] of bamboo. The Basic concepts of perpendicular pieces are found in bamboo. Its height is 2 fit and thickness is 1.5 fit. It is made by sunuwar Rai peoples".





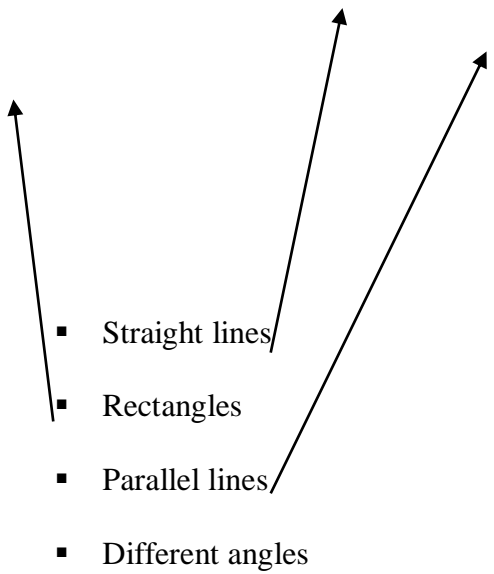
There are few geometrical concepts in Chhapani. It is cone in shape as well as there are many perpendicular lines. We can Chhapani to give examples for solid, straight lines, perpendicular lines while teaching in the classroom.

Mathematics in Bhar. Bhar is a very important object used in Rai community.

The respondents said that,

"It is hunged above the Raichula. It lies in 1.5-meters distance from chula. Its length is 5 hat that means 2 meters. It is made of small pieces of bamboo. It is used for drying corn, millet, meat, sukuti of buffalos, drying meat etc. If we dry boiled meat in Bhar then meat willnot be damaged for long time".

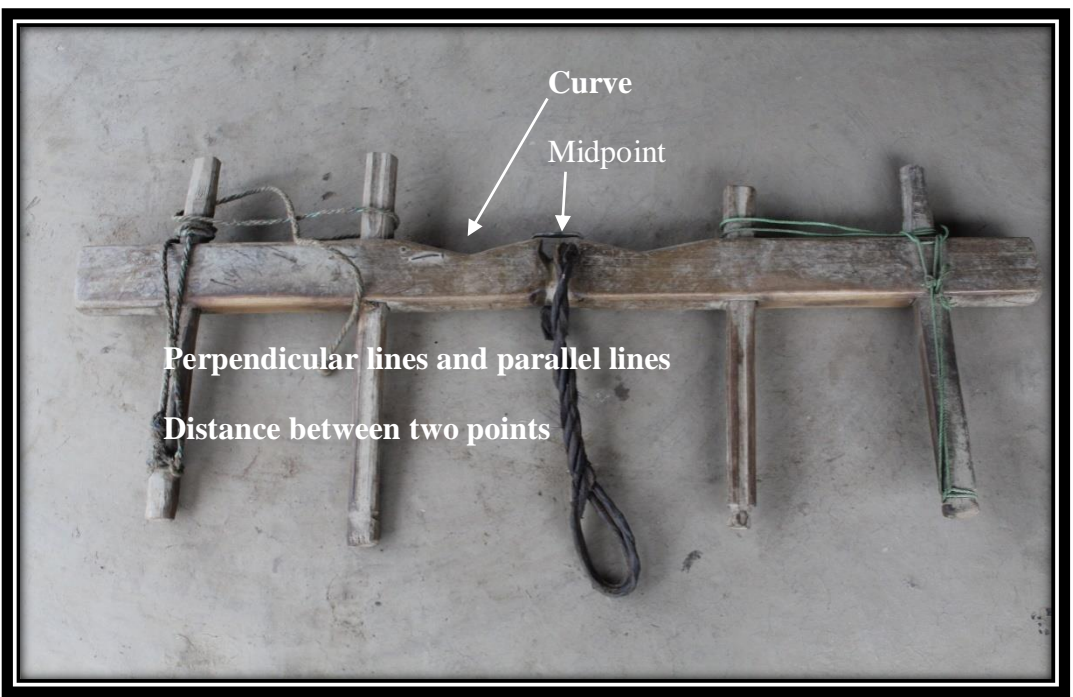




There are different types of geometrical concepts found in this object. We can find some holes are rectangles and some pieces of bamboo are parallel. Moreover, there are many types angle angles[between two parallel lines made many types angles] like, alternative angles, corresponding angles, internal angles etc. so it can be used to teach the concepts of rectangle, parallel lines, alternative angles and interior angles at the school geometry if we consider it as a teaching object.

Mathematics in Juwa.The respondents of the study replied that,

"These were a kind of object made from wood and used to join two oxen. This object is constructed by using the process of perpendicular lines, parallel lines, midpoint, curve, angle, slope and distance between two points. The shape of this object was slope and straight line. They make this object in such a shape so that they became able to use object for ploughing the field".



We can see that four straight legs of Juwa which is called soila and they are perpendicular to Juwa. Juwa is in the slope form but four legs are parallel to each other. The distance between a pair of Soila has around one Bitta. We can see that the Hadulghar at the mid-point of Juwa and the curve shapes at the left and right of Hadulghar. Therefore, by using this object, we can teach the basic geometrical concepts of perpendicular line, straight lines, mid-point, slope and distance between two points, curve and angle at the school level.

Mathematics in Dhiki. The respondents of the study explained that,

"At first while making Dhiki, the two parallel poles are (locally is called Mudka) buried with the distance at least one Bitta. The two poles are perpendicular to the land, Mudka and Dhiki are connected by Agla. In front of Agla and Dhiki there are about three hands far from its musal which is connected perpendicularly to the Dhiki which beats the grain on semi spherical hole which is locally called as Okhal. It is a kind of traditional machine constructed by wood and used for beating paddy, rice, and other grains". They make it in such a shape so that they are able to beat more grains easily.



In this object, we can find the different types of school geometry like angle, parallel lines, etc. The two poles are parallel and two poles are perpendicular to the land and Agla. In this object Musal is joined to the Dhiki with making 90° angle and the shape of Okhal is semi-spherical. So by the observation of this traditional machine

we can teach the basic geometrical concepts of parallel line, perpendicular line, straight line, semi-sphere and angle at school level.

Mathematics in Raga

Raga is one of the objects used in Rai community. At the time of field study, I asked research questions to two of my respondents from Rai people as a group discussion about basic geometrical concept, which are used in their daily life activities by the help of interview guidelines. Then they replied that,

"It is used around in their field to protect the vegetable from chicken, sheep, goat and other animals. It is constructed by small pieces of bamboo by using the parallel line procedure. It is made in such a shape to protect the vegetable because any domestic animals cannot pass through the holes between any two parallel lines".



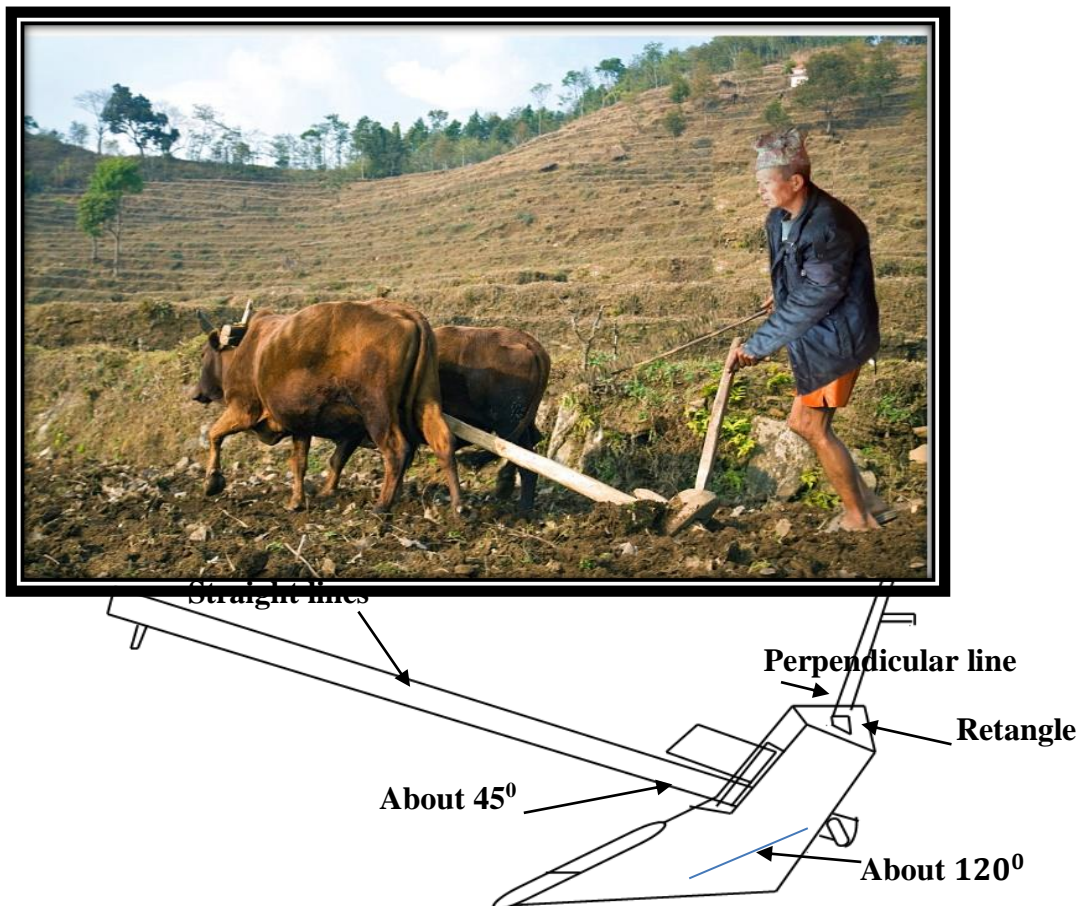
This object shows that every small pieces of bamboo are parallel and perpendicular each to other. There are rectangle shape, parallel lines, angles and curve found in Raga. This is the example of parallel line, rectangle, straight-line through which the student can understand easily.

Mathematics in Halo (plough)

Halo is a one of the important objects used in Rai community. The two respondents about this objectsaid that,

"It is a kind of ancient machine constructed by wood in angle shape and used for ploughing field".

They used the concepts of angle, slope and perpendicularity for the construction of this object. I found that it is around 45° angle between Haris and Phali (Iron piece) but plow is constructed around 135° angle. They made it in such a shape to plow large area of lands at a time, which is pulled by Juwa by oxen with the help of juwa".

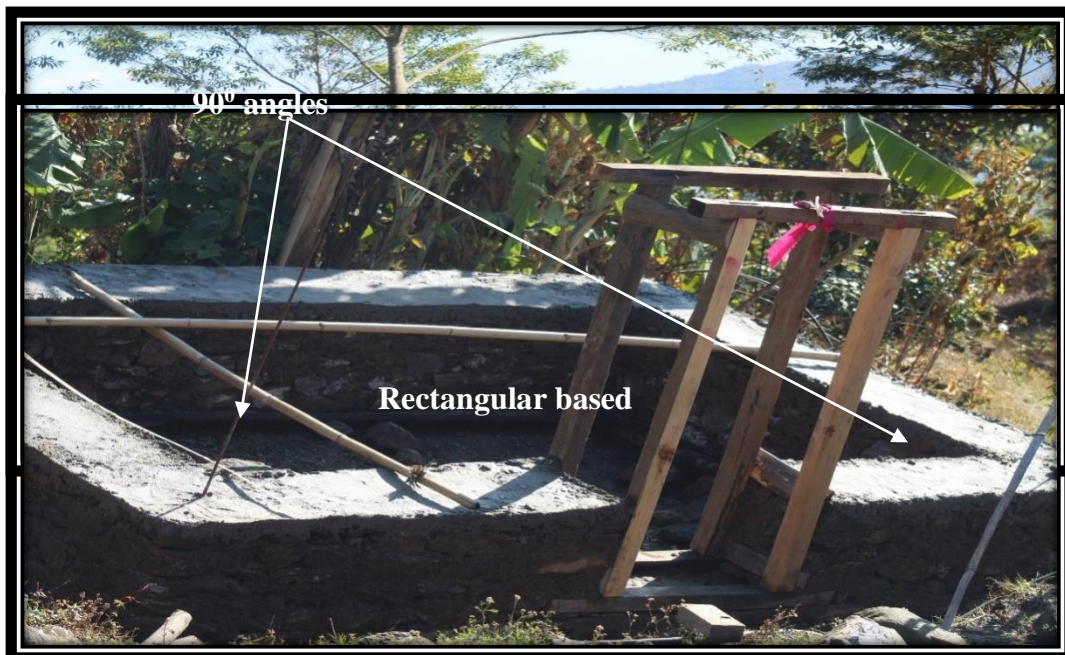


This object shows that the different types of geometrical concepts. There is 45° angle between slope Haris of plough and 120° in the base of Plough. This implies that angle of plow is around $45^{\circ} + 90^{\circ} = 135^{\circ}$ angle. In addition, we can see the concept of perpendicularity in the handle locally which called known as Anau that is made in around 150° angle and joined to the back side of plow. Therefore, it provides the clear concepts about angle, sum of angle, rectangles, slope, straight line and perpendicular line at the school level to teach geometry.

Use of Mathematics in Construction of a House. At the time of field study, I asked to one of my respondents about his concepts of geometry, which he used at the time of construction of a house with the help of interview guidelines. Then he answered me that,

"Normally he constructed the house in the rectangular base. While constructing the house he used the concept of Pythagoras theorem unknowingly at that time. When he made every corner of the house in 90° angle because every corner of house must be 90° . He said that in a rectangular base house if one corner is in 90° angle then other three corners must be in 90° angle itself. He said generally length is 18 haat and bregth is 15 haat which means 18 Fit and 15 fit".

For this concept he has used the concept of Pythagorean triple (3, 4,5) but he did not know what Pythagorean triple is.



In the construction of a house, he used the several basic geometrical concepts. In this process, we can see that the combinations of rectangles and squares are found again in a rectangle shape. Some rooms are rectangles and some are squares in shape. Every corner of the house and rooms have right angle.

Use of Mathematics in making Window and Door.I asked to one of my respondents who was carpenter about his geometrical concepts used to make the door and window with the help of interview guidelines. Then he told me that,

"The shapes of these objects are perfect rectangular and used for making attractive rectangular holes on the wall of a house".



In these objects, there are different types of basic geometrical concepts. We can see that the combinations of rectangles are again a rectangle. All corners of the window are right angles. Some straight pieces of wood are parallel and some are perpendicular to each other. As a whole, these are rectangular in shape. Therefore, by using these objects we can teach all the rectangles like as parallel line, perpendicular line, right angle, straight line and combination of rectangles are again in a rectangle shape if we use this object as a teaching object.

Chapter V

Summary, Findings, Conclusion and Recommendations

This chaptersummarizes the collected data from the sources like primary and secondary as the findings of this research study and carries out the conclusions of this study. Finally, implications of this research study and some recommendations for further research are highlighted.

Summary and Findings

This is the case study related to find the geometrical concepts practiced in Rai community. In this chapter, I have presented the findings of the study, conclusions of the study and implications of the study. The objectives of this study were on the basis of geometrical concepts practiced by Rai community and pedagogical implication of mathematical practiced in Rai culture. The study area was Shadhananda municipality of Bhojpur district as the field of research and sample size selected by the purposive sampling method. For the study fifteen members were selected and among them two were females and 13 were males. During the analysis and interpretation periods of my research work in the previous chapter, I have answers collected from respondents to my research questions; what kind of basic geometrical concepts did Rai community practice? How can their geometrical concepts be linked with teaching learning geometry? For this purpose, I visited the Rai community and observed their basic geometrical concepts. In this study I collected by observation, interview and informal discussions and at the same time, I took photos of different domestic object. On the basis of their information and field data I have presented the following findings, conclusions and implications of the study. The findings of the study are as follows:

- Almost selected Rai farmers are not literate and unfamiliar with formal geometry. However, they always used the concepts of formal geometry to construct domestic objects knowingly or unknowingly.
- They make first conceptual shape and size in their mind of the concerning domestic object to construct it.
- The circular, conical and rectangular shaped objects are mostly preferred.
- The parallel and perpendicular lines procedures are mostly preferred to construct different types of domestic object.
- They are not able to distinguish between the different types of geometrical shapes, such as parallelogram and square, circle and semi-circle and semi-sphere.
- Some house maker and carpenter are able to relate their cultural geometry to the school geometry or curriculum geometry.
- They use the process of regular hexagon, square, and parallelogram, rectangular and triangular holes to construct some domestic objects.

- They are not able to tell and show the shape of some domestic object just for show, but they are able to tell and show the shape of each part of some domestic objects.
- Rai students are poor in school geometry whose guardians are not literate and unfamiliar with school geometry.

Conclusion

There are several ethnic groups with their own typical traditions and practices. Different groups have their own geometrical concepts and practices. The Rai community is also one of the ethnic groups of Nepal. The Rai people have their own traditional artifacts that they use many domestic objects in their day-to-day lives. They use their own traditional geometrical knowledge and practices in their daily life knowingly or unknowingly. Their geometrical concepts are directly linked with formal geometry and are essential for understanding the formal geometry education. However, the geometrical concepts of Rai community have not been expanded, explored and linked with formal geometry.

It shows that they use the different types of basic geometrical concepts in their daily life activities such as concepts of square, triangle, circle, cylinder, rectangle, diagonal, demi-sphere, slope, parallel lines, and straight lines and so on. We can use their geometrical concepts at school level as a teaching object to teach the basic concepts of geometry and thus formal geometry would certainly be increased in their community.

In conclusion, the geometrical knowledge is strongly embedded in socio-cultural activities of the Rai community. School geometry can be more interesting and worthy while linking it with socio-culture activities such as religious ritual, cultural object, cultural objects and artifact. Similarly, in teaching learning process of mathematics can be easy and effective by linking formal mathematics to daily life mathematics and this study helps to improve pedagogy of mathematics teacher. Ultimately, it also helps the students and teachers to improve their fields. Likewise, this study is applicable to curriculum maker, textbook writer, policy maker, in-service teacher and out-service mathematics teachers.

Recommendations

This study took short time period, small number of respondents and limited in several aspects. The findings of this study may have covered certain field of mathematics of Rai ethnic group. So considering these limitations of the study, the following suggestions and recommendations have been made for further researcher.

- This study was limited to the basic geometrical concepts practiced by Rai community only.
- To find the teaching object available in the local community, which is available easily without cost and students can understand the concept meaningfully that makes teaching learning effective and fruitful.
- There are many ethnic group which have their own geometrical concepts in Nepal. So similar study can be done in other ethnic group.
- This study was limited only in Sadhananda municipality -2 kudakkaule. So further researcher can also be done in other places as well as on how the children of Rai community learn mathematics especially geometry parts in classroom teaching and link with their daily life activity.
- There are many mathematical knowledge in socio-cultural activities that can be linked with formal curriculum and these objects can be used in local mathematics curriculum in primary level.

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Appendix I

In-depth Interview Schedule for Rai farmers

Personal Details:

Name:

Sex:

Age:

The interview with Rai farmers will take in the following topics:

- Materials used in farming
- Materials used in DhanRopai
- Materials used in Plough in field
- Measurement scale to make these materials
- Making process of these all materials

Follow the question will be ask during the interview.

In-depth Interview Schedule for Rai senior educators

The interview with Rai senior educators will take in the following topics:

- Main materials use in Culture
- Materials use Traditional culture and Modern culture
- Geometry in Cultural Dress and Ornaments
- Traditional Foods and Solid Objects
- Measurement scale to make these materials
- Making process of these all materials

Follow the question will be ask during the interview.

In-depth Interview Schedule for Rai Housewife

The interview with the Rai Housewife will take following points:

- Goods use in kitchen
- Use in main festival
- Ornaments
- Making chhyang,Raksi
- Materials use to making chhyang, Raksi

Follow the question will be ask during the interview.

In-depth Interview Schedule for Rai Professional to make artifact

The interview with the Professional to make artifact will take following topics:

- House design and size
- Door and windows size
- Measurement system
- Area, volume, weight

Follow the question will be ask during the interview.

In-depth Interview Schedule for Rai Leading to social activities and cultural rituals

The interview with the Leading to social activities and cultural rituals will take following topics

- Main goods to use in Rai culture
- Importance materials
- Trend of materials

Follow the question will be ask during the interview.

Thank you