

**PHYSICO-MATHEMATICAL CONCEPTS IN EVERYDAY ACTIVITIES:
A STUDY FROM CULTURAL-PSYCHOLOGICAL PERSPECTIVE**

*Dissertation Submitted to Jawaharlal Nehru University
In Partial fulfillment For the Award of Degree of*

MASTER OF PHILOSOPHY
(Social Psychology of Education)

Submitted by
Himani Pasbola



**Zakir Husain Center for Educational Studies
School for Social Sciences
Jawaharlal Nehru University
New Delhi 110067
India
2005**

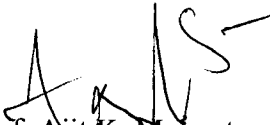


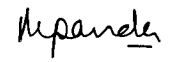
ZAKIR HUSAIN CENTRE FOR EDUCATIONAL STUDIES
SCHOOL OF SOCIAL SCIENCES

CERTIFICATE

This is to certify that the dissertation titled, “**Physico-Mathematical concepts in Everyday Activities: A study from cultural-psychological perspective**” submitted by **Himani Pasbola**, in the partial fulfillment of the requirements for the award of the degree of Master of Philosophy. This is an original work and has not been submitted so far, in part or full, for any degree or diploma in this University or any other University.

We recommend that this dissertation may be placed before the examiners for evaluation.


Prof. Ajit K. Mohanty
(Chairperson)


Dr. Minati Panda
(Supervisor)

CHAIRPERSON
Zakir Husain Centre for
Educational Studies
School of Social Sciences
Jawaharlal Nehru University
New Delhi-110067

DEDICATED
TO
THE PILLAR
OF STRENGTH IN MY LIFE
MY
'PARENTS'

ACKNOWLEDGEMENT

It is with extreme gratitude that I acknowledge the sincere efforts and guidance provided by my guide Dr. Minati Panda. Her unending guidance, timely corrections and constant motivation gave me the necessary impetus to complete this study.

The valuable suggestions provided by my teacher, Prof. A.K.Mohanty who is also the Chairperson of the center, helped me immensely in formulating my study. I find myself short of words to thank him but with extreme gratitude I, hereby, acknowledge his sincere efforts.

I also express my sincere thanks to the staff members at NCERT library, Central Library JNU and at HNB Narwhal University, Srinagar who helped me in gaining access to the required material.

My friends in the Centre provided me support whenever needed. I would use this opportunity to also thank Mr. Bisht who helped me a lot during my field work by guiding me through the Himalayan terrains.

I also extend my thanks to all the staff members at the Center for their co-operation with special mention of the librarian at our centre's library, Seema, who provided me the required material on time along with Ghani sir for the cooperation displayed.

My parents' unconditional love and support was my pillar of strength throughout the span of my research work. Both my younger sisters helped me in their own simple ways and motivated me to do my best.

At the end I would again like to thank all the above-mentioned people who helped me in conducting my first full-fledged research work. Without them it would not have been possible for me to do my job satisfactorily.

CONTENTS

CERTIFICATE

ACKNOWLEDGEMENT

ABSTRACT

CHAPTERS

PAGE NO.

1) INTRODUCTION..... 1-18

1.1) IMPORTANCE OF CULTURE

1.2) CULTURE AND ITS IMPACT ON THE COGNITION OF PEOPLE

1.3) MATHEMATICAL IDEAS-HOW CAN THEY BE DISTINGUISHED FROM OTHERS?

1.4) INDIGENOUS KNOWLEDGE

1.5) ETHNOSCIENCES

1.6) IMPLICIT SCIENCE AND TECHNOLOGY IN INDIGENOUS KNOWLEDGE

1.7) TRANSMISSION OF KNOWLEDGE IN TRADITIONAL SOCIETIES

1.8) THEORETICAL BASE FOR THE STUDY

1.9) NEED FOR THE STUDY

2) REVIEW OF LITERATURE

19-37

2.1) CULTURE AND COGNITION

2.2) LEARNING AND SITUATION ARE INTEGRALLY RELATED

2.3) EVOLUTION OF MATHEMATICS AND SCIENCE AS A CULTURALLY SPECIFIC KNOWLEDGE

2.4) CULTURAL SPECIFICITY AND COGNITIVE DEVELOPMENT

2.5) TRANSMISSION OF TRADITIONAL KNOWLEDGE TO CHILDREN

2.6) SUMMARY

3) METHODOLOGY

38-50

3.1) PROBLEM STATEMENT

3.2) RESEARCH QUESTIONS

3.3) RATIONALE OF THE STUDY

3.4) OBJECTIVES OF THE STUDY

3.5) SAMPLE

3.6) INTRODUCTION OF GARHWAL REGION IN UTTARANCHAL

3.6a) INFORMATION ABOUT THE VILLAGE

3.7) *DESIGN OF THE STUDY*
3.8) *DATA COLLECTION*
3.9) *PILOT STUDY*
3.10) *DATA ANALYSIS*
3.11) *TOOLS FOR THE STUDY*
3.12) *CHECKLISTS OF THE SAMPLE ACTIVITIES FOR DATA COLLECTION*

4) DATA ANALYSIS AND DISCUSSION **51-75**

5) CONCLUSION **76-80**

BIBLIOGRAPHY **81-85**

ABSTRACT

This study aimed to find the relation between the cognitive evolution in a human being and the culture in which the person is situated. An attempt has been made to explore the various everyday activities taking place in a village in Garhwal region in order to elicit the physico-mathematical concepts embedded in them. The major goal was to study the level of notional understanding of these concepts among the garhwali villagers who use these concepts in their daily life.

The narrations provided by the villagers on different areas revealed that their methods of doing various activities were based on their efforts to adapt to their immediate surroundings. The manner in which they perceive, interpret and adjust to their environment shapes their cognitive ability and hence behaviour. Their house construction style, agricultural practices and tool making are found to be related to the availability of resources, climatic conditions and other ecological considerations in the region.

The villager's account of their cultural practices provides support to the idea that all forms of knowledge are constructed in a socio-cultural milieu. The variation found in the working style of different people in different situations is contingent upon this factor. The study revealed the rich, traditional wisdom of the garhwali villagers, which forms a base for their unique and indigenous ways of adjusting to their environment. These people have not been formally trained or educated in any institution yet they have a very clear understanding about how to carry out their everyday activities so that it is conducive to their cultural surroundings.

This cultural specificity of the acquisition of knowledge provides them necessary confidence to use it in the unforeseen practical situations wherever needed. Most of the learning by their ancestors was done through the process of trial and error and their experiences with their environment. Their frequent encounter with the surroundings result in new and innovative strategies that come up so as to satisfy their daily needs. These strategies reflect their in-depth understanding of the topography, biodiversity and other such crucial factors, which shape their lifestyle in one way or the other. Their houses, fooding habits, clothing etc. shared a direct relationship with the outside environment as it decides their form. One need to keep all the background factors in mind

while analyzing the activities and behaviour of any person. These factors may not be very explicit but still they play a very important role in the cognitive development of a person.

The present study lends partial support to situatedness of knowledge acquisition. Such forms of learning give relevant meaning to the acquired knowledge thus making it easier for the person to retain it and also use it in related situations. It provides the person a more realistic way to conceptualize any practical situation. Mostly people find it difficult to apply the formally acquired knowledge in new situations. Learning in a context removes such difficulties. Therefore in this study an attempt has been made to probe the traditional garhwali culture and explore the hidden science and mathematics in it.

CHAPTER 1- INTRODUCTION

Traditional views about the relationship between science, technology and society revolve around the idea that science is a purely objective and rational process driven by a humanistic desire to accumulate knowledge. The absolutist view about mathematics forms the base for such a belief. Under it, mathematics is seen as an infallible, objective entity, which holds a place far away from the affairs of the society. Everybody grows with an idea that 'science' is something what a scientist does sitting in his laboratory, away from the real world, where he conducts experiments and makes new discoveries. Lerman (1990), discussed about the various kinds of absolutism, which decide the form of mathematics. This view explained mathematics as a consistent, certain and complete discipline, without any relationship with the real world.

However, since 1970, philosophical study of social dimensions of scientific knowledge has gained interest among the researchers. The works of Mill, Pierce and Popper provided a strong base to the philosophers who wanted to explore the social dimensions of scientific knowledge. Kuhn (1962) in his book 'The Structure of Scientific Revolutions' stated that science is a communal activity, which takes place as a part of any community. His argument is based on the idea that any observation and evaluation process takes place within a paradigm, which is what the members of a community of scientists share.

Kuhn rejected the idea of isolating a theory being tested from the ground where it is situated. His theory of history of science allows us to see the development of new scientific values in the light of changes in the larger world where science is situated e.g. economics, politics, religion etc. It therefore leads us to a notion that epistemology, theory and factual content of science, all are related to changes in the great historical epoch. Kuhn's theory was a great starting for the historians studying history of science as it allowed them to utilize the works of anthropologists and sociologists. Kuhn outrightly criticized Logical empiricism with his concept of Naturalism. He (1962; 1977) puts forward the need of studying actual episodes in the history of science in order to develop an understanding of scientific rationality. He also rejected any analysis done on the basis of previously developed concepts of knowledge and reason. Thus, philosophy of mathematics underwent a revolutionary change with the introduction of Kuhnian theory.

The infallible status of mathematics was now objected on the ground that it makes the discipline completely detached from society and its activities. The advocates of the fallible nature of mathematics defined it as a body of knowledge that develops with effort of human beings living in a society and continuously evolve in their efforts for survival. This concept of fallibility inculcates dynamism into mathematics teaching in schools. It provides a multicultural approach to the subject along with making it more learner friendly. It leaves enough space for the possible evolution of the subject in the light of changes in the larger societal context. Lerman (1990) favored the fallibilist view saying that mathematics is a continuous activity under which people try to find solutions to their problems, and further develop it as per their needs. This view gives enough confidence to the learner to display their innovative power and tackle the problems in their own way thus making the learning process interesting for them.

The concept of absolutism, on the other hand, restricted a child's engagement with a problem within the periphery of school learned mathematical ideas. It assumes the transfer and application of school-learned mathematics by the people to real life situations. But it is seen that most of the people fail to use classroom mathematics in practical situations. Lave (1988) proposed that all types of learning takes place in a specific context and that is why children find it difficult to apply their school knowledge in other situations. As the child acquires knowledge in specific school setting, hence he finds it difficult to comprehend and apply it in new practical situations. Dugan (1994) said that science and technology are inherently social in nature, hence their artifacts, symbols, knowledge all are reflective of the socio-historical context in which they are situated.

One of the most important implications of adopting a fallibilist view of mathematics was that it allowed us to see mathematics, as a knowledge base with a social and cultural history. Under the dominant effect of the absolutist paradigm ethnomathematics was confined to the background. With the adoption of Kuhnian concept, it now became possible to explore various ways of doing mathematics in different cultures and the reasons, which were responsible for the adoption of such methods. If we delve deep into the history, we come across several such examples of technological advancements that were not borne out of 'formal' conventional scientific methods.

IMPORTANCE OF CULTURE

The concept of culture has always been an integral part of the curiosity one has about the human mind. Culture and Psychology both have had their share of closeness and aloofness as per the interest of the contemporary researchers. The founding fathers of academic Psychology, that is, Wundt and Bartlett both were of the opinion that culture plays a very important role in Psychology in one way or the other. But with the coming up of newer schools of Psychology, namely Structuralism and Functionalism, culture lost much of its say in Psychology. During this phase the concept of culture got detached from Psychology. From the works of Neisser (1967) and Gardner (1987), we get to know that during the cognitive revolution of the 60's, the idea did come back to Psychology though in the form of information processing psychology. The concept of meaning got lost somewhere in between. Bruner (1990) who was a prominent contributor to this movement, complained about this situation where cognitive processes could be compared to nothing else but the computer programmes, which do not have any meaning but only have computability. As a part of this revolution, his main aim was to reestablish meaning as the central concept in culture and psychology.

In late 1980's and early 1990's, 'Cultural Psychology' or 'Transcultural Psychology' evolved as a new discipline in North America. Its main aim was to avoid the ethnocentric disciplinary bias that was limiting the scope of the studies in the social sciences. Along with Psychology, other academic disciplines and sub disciplines such as sociology of culture, anthropology, cultural studies etc. also recognized the importance of culture in their researches. As regarding the growth of cultural Psychology, the credit can perhaps be given to the book entitled '*Psychology: Essays on Comparative Human Development*' (1990) edited by researchers namely Stigler, Schweder and Herdt.

CULTURE AND ITS IMPACT ON THE COGNITION OF PEOPLE

To think of a human being's existence in isolation either from his community or the group culture is an unimaginable task. Human beings grow or develop in a specific physical, social and cultural context. In order to survive, man continuously interacts and alters his environment. The adaptability of people, individually and socially, to naturally

or artificially occurring environmental situations is striking. All these interactions result in the coming up of certain man made things like houses/dwelling units, food habits, weapons and implements, folklore etc., which are important features of his culture. All human societies rely upon their accumulated learning or cultural knowledge for their survival.

The child is the future torchbearer of his family and hence culture. Thus to keep the cultural heritage alive, he or she is trained from the very beginning to think and act in a socially acceptable manner. This cultural rooted ness of a child's actions is indicated by Reagan (1996). A child in order to become a member of the group tries to behave in conformity with culturally approved behavior through the effect of the child rearing practices. Sullivan (1950) also emphasizes the importance of culture when he says that personality development in any person takes place in a particular cultural context. Kroeber (1953) in his study on development of comparative cultures and Hare (1962) in his study on social processes, found that personality is the resultant of the blending of persons and social situations. These findings find support from those of Kardiner (1939), Linton (1947), Gerth and Wright (1970).

Culture can be called as a great storehouse of readymade solutions to all the problems of the inhabitants. It signifies a dynamic word of multiple practices, interpretations and imaginations. It is the collective utilization of natural and human resources in order to achieve desired outcomes. People confront the world in some objective ways, which is defined by their culture. They think, act, perceive and do other activities all according to their culture. People in a community or society have a relatively stable system of shared meanings, meaningful symbols etc. which guides their various experiences with the outside world. Traditional cultures are supposed to exhibit specific forms of local knowledge consisting of ideas and practices, which allows its inhabitants to understand and manage nature in a sustainable way.

Thus, psychological phenomenon is fashioned from and reflects the structure of social activities and the natural environment. They consist of concepts, which are inspired by social activities and natural conditions. With this flows the idea, that whether it is a cognitive or a socio-psychological research, the researcher should make it a point to study everyday knowledge, its content, structure, and function along with its social constitution.

MATHEMATICAL IDEAS-HOW CAN THEY BE DISTINGUISHED FROM OTHERS?

Mathematics and science are generally thought to be the domain of the intelligent and brighter lot in the school. It has the reputation of a subject generally feared by the students. Generally people think that mathematics is something concerned with quantification and without it there is no mathematics. Not everybody is good at numbers so this restricts knowledge of the subject only to a selected lot. But it is to be understood that mathematics is not only a discipline but also one of the ways of thinking. It can be learned formally inside the school or can develop informally while doing various social activities of playing, building houses, selling, buying etc.

Mathematics is all around us in our everyday activities although it may not be very explicit. This idea makes mathematics available to all the people which was till now considered to be the domain of the more intelligent lot owing to its popularity as difficult subject. Children mathematics learning is not independent of the complex social setting in which they are situated. On principle grounds, it is though possible to term a child's learning of mathematics as a purely cognitive matter. Yet this form of analysis is not quite possible in practice. It is an important point to be noticed that a child's learning process is not totally a cognitive phenomenon rather the social factors form the real base for such practices to develop.

Paul's Gerdes (1988) dealt with this idea very effectively in his paper on culture, geometrical thinking and mathematics education in Mozambique. He says that African's build their houses in a traditional manner. By taking out the hidden scientific concepts in it, we can incorporate it in our style of teaching science and mathematics. Indigenous knowledge is transferred through generations by the process of imitation but the ones who initially came up with these ideas thought very scientifically and mathematically. When we try to decipher the hidden knowledge in these ideas then we actively engage in mathematics.

While playing darts or for that matter any other game, the player is continuously engaged in some sort of calculation in order to improve his chances to succeed. It may not involve use of proper mathematical ideas .It is the player's innate understanding of the game and its conditions through which he develops his own methods of calculating.

These methods are no less, than the conventional mathematics, owing their informal approach. They are infact clearer to the person because he or she understands the implicit meaning in them better because of him being a part of the context in which these practices are developed.

Generally any type of social activity is based on the laws of geometry, physics thus guiding all types of technological development by human beings. But even while doing certain everyday works based on them like piling the goods, flying a kite etc. we may not be aware of the scientific knowledge, which guides them. Hence we cannot say that this scientific knowledge was consciously used in them. Several times it happens that even the inhabitants of a community are unaware of any such thing while doing their day-to-day activities. To them it is only a way of doing any activity, which they have developed by the process of trial and error through their frequent experiences with their surroundings.

A person belonging to any culture comes across a number of activities involving mathematical ideas like measuring, counting, dealing etc. All of them are contextualized in a specific cultural situation. For example, a shopkeeper in a shop is continuously engaged in measuring goodies and calculating money. He has not been formally trained in any school, which taught him the idea about measures etc. It is his own accumulation of knowledge, which has been formulated by his continuous experiences with his work and workplace. Technically speaking, all such activities can be grouped under mathematics as they involve dealings with numbers and measurements. However, if the same person is put in a classroom situation where he is required to solve questions with the application of formal mathematical formulas, then it is very likely that he may not be able to do so satisfactorily. Formal application of mathematical ideas may appear difficult to him, as it requires a very systematic approach to the problem.

Mathematics can, thus, be called a socially defined activity as the children's social representation of mathematics has a considerable impact on their way of approaching a problem. The phenomenon of 'Street Mathematics' given by Nunes, Szhliemann and Caraber in 1993 provides the most effective demonstration of the strong effect of situations on children's approach to mathematical problem. Children refer to or attend situations involving similar mathematical reasoning very differently and this difference in approach depends on their prior understanding of mathematics and its various concepts. But because of its crude representation this form of knowledge is not given much

importance by the people. They feel such type of contextual knowledge is not of much help as it limits the scope of thought processes in a person.

INDIGENOUS KNOWLEDGE

Local knowledge is a collection of pragmatic notions and skills, which are put into practice by any traditional community in all their everyday activities. It includes all areas from health, soil sciences, market behavior etc. It imparts skills and competence to the otherwise illiterate villagers to deal effectively with their environment. It is unique to a given culture or society. It forms the basis of community level decision making in the areas of agriculture, fooding habits, natural resource management and other such activities that take place in any traditional community. These indigenous information systems are dynamic in nature, undergoing continuous evolution by the natives who incorporate new ideas into them as per their experiences and requisites. They develop outside the domain of formal educational system that focuses on imparting formal, bookish knowledge to the learners.

One more characteristic feature of such knowledge systems is that they are orally transmitted which means they are not documented in black and white. They are holistic in nature and evolve as a result of an individual's effort for survival and subsistence while exploiting the locally available resources to meet his needs. We can call it as an accumulation of practical knowledge by a group or community overtime while exploring and exploiting their surrounding environment in order to adopt a balanced and comfortable lifestyle.

The indigenous knowledge is more localized, contextual and specific. It consists of rules and guidelines to carry out an activity effectively in a particular area. A farmer situated in some area will have a much in depth information about his area and hence would be able to interpret the various situations that come across more quickly and correctly. An educated well informed specialist would definitely have diverse knowledge in the field of agriculture but not an in-depth one, which makes him an expert only for a specific area.

The traditional units of measurement are qualitative in nature and thus come up as a more detailed and reliable method of measurement. When measuring a piece of land in modern terms, we make use of universal units such as hectare. Such units measure all land pieces as equal, even though they may be different on grounds of

productivity, location etc. Thus it is not a feasible practice as it leads to unbalanced measurement of land. Traditional measurement units are comparatively more technically sound as they are based on qualitative factors, for example, the amount of time needed to till a piece of land, the amount of seeds to be sown for a good harvest etc. and hence they provide a more reliable measurement of any type of commodity. Traditionally more amount of a coarse variety of an object is given in exchange for a good variety of a commodity. This traditional system believed in equalizing the two available varieties and for this they used their indigenously developed methods. These illiterate traditional village people did not had access to the formal scientific knowledge imparted in schools. Their elders eventually have transmitted this knowledge to them while they actually took part in an activity. So they learn majorly by 'doing' or by actively participating in some activity.

Culture and environmental context both share a direct relationship. Both depend on each other for their existence. Culture shapes according to the surrounding environment and human beings interact with their environment as directed by their cultural norms. Local expertise is dynamic in nature as it concerns both natural as well as the social environments. While formulating methods for doing any work, people take into consideration social, ecological, economic all types of factors.

When the development authorities try to infuse any technological innovation into the working style of the villagers, then they feel that they have done a great job of informing the villagers about the available technology and its uses. The people whom they consider ignorant are the ones who came up with the technological concepts initially. Probably due to lack of formal education they are not able to articulate it. But this does not mean that they are devoid of knowledge in any way.

The indigenous knowledge system easily blends with the modern scientific and technical knowledge in its effort to solve the social and economic problems prevalent in the society and thus both complement each other. Because of the dominance of Western Formal Education system in the education arena, indigenous knowledge has lost much of its importance. People seem to have forgotten that it was the indigenous knowledge only, which provided the initial remedies to them in their encounter with the surrounding environment. Due to lack of sophisticated and formal systematic approach, this local scientific knowledge has failed to get due notice from the policy makers.

ETHNOSCIENCES

Ethnoscience or Cognitive Anthropology is the study of people's perceptions of their surroundings as reflected in their use of language. Both mathematical as well as physical sciences exist together under this domain. Martin (2001) defined it as the study of interactions and of traditional knowledge of physical and biological world. It can be referred to as the corpora of knowledge established as systems of explanations and ways of doing which are attained by generations in specific cultural environments.

Ethnomathematics comprises of knowledge, which one acquires by engaging in quantitative and qualitative practices consisting of counting, weighing, measuring, sorting and classifying. All such ideas concerning the cultural and historical roots of mathematics along with the ones dealing with the implicit mathematical ideas in everyday settings together comprise Ethnomathematics. Both ethno science and ethnomathematics share a symbiotic relationship and we can find their existence in everyday practices of the people living in traditional communities. Such forms of knowledge allow the individual to be a part of problem solving mechanism. People here are actively involved in finding solutions to their problems and also the reasons responsible for the occurrence of the problem.

Any community or culture generates, organizes and eventually transmits certain practices in order to satisfy the immediate needs of its population. These practices are incorporated in a pool of common knowledge namely culture and this bounds a group of people, a community or society together. That is why different cultural patterns exist in terms of values, beliefs, societal norms, dressing, eating habits etc. and all these are contingent upon social and historical background of the community or group where they develop. Right at his birth the child is exposed to the values and practices of a human group. Very early in life he or she becomes a cultural being by learning the ways of their group. Anthropological literature is rich in examples of how culture affects a young child's perception, values and behavior.

Various terms are used for Ethnoscience, namely indigenous knowledge, local or traditional knowledge and so on. Folk psychology informs us about the different ethnotheories developed by a society in its bid for survival. Bruner (1996) used the folk

psychology concept in explaining the reasons for a person's behaviour. These are continuously evolving, time-tested adaptations of the people to the environment in which they develop. They provide them a base to take practical decisions in areas such as human & animal health, agriculture, natural resource management and conservation. Historically and contemporarily, ethnosciences have been found to play a significant role in determining hypotheses, research designs, methods and interpretations employed by modern science.

IMPLICIT SCIENCE AND TECHNOLOGY IN INDIGENOUS KNOWLEDGE

People in the traditional societies possess indigenous knowledge, which helps them in curing ailments, using irrigation facilities, in managing natural disasters, making tools and using them etc. The people produce this local or popular knowledge in their effort to deal with the surroundings with the help of locally available resources. Tim Ingold has defined technology as a "corpus of culturally transmitted knowledge, expressed in manufacture and use." Among the villagers, technology is nothing but a way of life. It has very little influence on what people think about the activity. In traditional societies, villagers construct their own houses and make their own tools and equipments. They may not be able to explain scientifically the logic behind their practices yet they know very well that what should be the height of their house, number of doors & windows, the roof type etc.? They are not sent to any school or college to learn it. Rather this knowledge is transmitted to them by their ancestors through the process of 'doing' or taking part in an activity. But this does not mean that his way is in any way less technological than modern scientific ways. This knowledge is their cultural heritage, which has been developed by them in the process of solving the problems of their social and cultural life.

Technologies and techniques are a part of the various processes that take place in a society and hence one cannot study them without taking into account the cultural and social background. In India we can take the example of the Goud and Santhal tribes who prepare an umbrella of teak leaves to protect themselves from the rain. This is a fine example of their local knowledge, which helps them in facing the natural phenomenon of rainfall with the help of locally available resources. Ethnoscience, or Cognitive Anthropology expresses how people perceive their surroundings and deal with them. Ethnophysiology, ethno biology all these are one or the other forms of ethnosciences.

They help to explore the meanings of the folk names and categories used to refer to landscape, plant and animals in different cultures.

Ethnomathematics is more like a history of mathematical knowledge. It does not deal with proper mathematical concepts and ideas such as arithmetic, algebra or theorems rather it is concerned about the various background factors through which these ideas originated. It thus shows social construction of knowledge at the cultural level. Such information can be very helpful in providing a multilingual database for studies in these areas. Broomes in 1989 suggested that everyday mathematics plays a superior role in the application of mathematical knowledge to practical, real life situations. It is so because people feel that this form of knowledge is their own and hence they can understand its implicit meaning in a better way.

A popular quote by Einstein is an apt reflection of the limited scope of the conventional mathematics taught in the schools. It says that:

“As far as the laws of math refer to reality, they are not certain; and as far as they are certain, they do not refer to reality.”

This conveys the idea that both conventional as well as local forms of knowledge are complementary. If we try to inculcate the folk wisdom in our mathematics teaching style it would make the subject much more approachable for the learner. The learner would be able to relate these concepts to his real life events thus making the learning process interesting, permanent as well as practically applicable.

Sciences, as generally understood nowadays, appeared as a form of understanding, explaining and coping with the natural environment in earlier times. Each community or culture generated such knowledge in some particular context with a motivation to solve the concerned problem. This knowledge is open to changes for improvement from time to time provided it doesn't affect the cultural heritage.

Ecology provides the base for technology. Popular or local technical knowledge evolved out of different kinds of thinking. People living in different cultures develop technological skills specific to their ecological conditions, which helps them in adapting well to their environment. It may or may not be logical yet it is popular as it meets the needs of the people. It makes possible the interpretation of the everyday practices of the traditional communities, thus giving them some meaning. It makes possible the introduction of new technologies among the people. The traditional communities have their own knowledge base according to which they carry out their activities. When some new idea or technique is introduced to them, then they evaluate, interpret and decide on

the basis of the pre existing norms grounded on their local knowledge. Thus the implicit scientific ideas in folk knowledge are of great use to the learner as they help him in the acquisition of modern scientific ideas and concepts.

TRANSMISSION OF KNOWLEDGE IN TRADITIONAL SOCIETIES

Learning and acting are instinct. Learning is a continuous, life long process, which results from acting in different situations. Knowledge comes coded by the activity and environment in which it develops and spread across its different parts, a part of which is in the mind and other part in the outside world. Conservation, problem solving etc.do share some sort of logical similarity, but because of their presence for different tasks and in different situations, the same person finds it difficult to generalize the knowledge learnt in one activity to another situation.

The occasions and conditions for use of a tool arise out of the context of activities of the community that uses the tool. The tool is framed according to the way members of that community see the outside world. That is why a difference is seen in the way a village farmer designs the plough and in the designing of universal modern tractors. The indigenously made plough by the farmer adapts to the environment easily as it has been designed in that manner. The modern technological wonder, that is, the tractor may suit most of the conditions but not all of them. Similarly the conceptual tools reflect the cumulative wisdom of the culture in which they are used and the insightful experiences of the natives. In traditional societies, learning do takes place but not as a formal separate entity rather it occurs in the process of 'doing' the work. It is more a process of learning while doing. This gives the learner a first hand experience of the work and he or she also feels confident in practically applying their acquired knowledge.

Eminent Anthropologists such as Fortes (1938) and Lave (1980) have denied the existence of teaching of instruction as a distinct activity in the traditional societies. Fortes (1938) made a statement about education in traditional, non-industrial societies that in it there is no systematic or regular pattern of training the young ones. In other words, the process of the development of understanding about the various traditional activities takes place among people as a by-product of the cultural practice. The entire process takes place informally although the approach is very systematic. Most of the parent child interaction is so structured that is promotes the development of the social and cognitive skills of the child even though to provide instruction to the child is not the aim of the

adults. Regarding this Fortes gives the example of the Tale education system, which trains the young ones in a realistic situation, where both the trainers and the trainee participate in the activity and eventually transfer of knowledge takes place.

Similar example is given in a study done by Lave in 1980 to examine the apprenticeship between Vai and Gola tailors in Liberia. In apprenticeship, instructions are given and knowledge is imparted yet there are several background factors that structure the learning process. Initially the apprentices are given small odd jobs and once they have learned these, they are then promoted to do higher skilled jobs of cutting the garments and sewing them. One step at a time is allowed for the apprentice so as to benefit the most from the productive capacity of the individual and to minimize the economic losses in the process. The technical training that takes place in Wogeo; New Guinea shows how the child acquires different skills by taking part in the activities. Initially the child does the role of an observer and when he has deeply observed the adult's actions while doing the activity, he then tries to perform it himself in the best possible manner.

Lave and Wenger in 1991 came up with a concept known as the concept of a community of practice (COP). They observed that in traditional communities people acquire knowledge depending on their age, level of authority, gender, status etc. This means that a newcomer is not inducted into the activity at the onset itself. Rather he or she is required to go through a series of stages of knowledge acquisition prevalent in the society. These stages are in a hidden form but are very important to be followed by every newcomer. Under this a newcomer learns by moving from the periphery towards the center. This means that he moves from being a mere passive observant to a full-fledged performer in the social arena. They called this process as Legitimate Peripheral Participation. It is an informal way of imparting knowledge to the novices by systematically inducting them into an activity, from the introductory or simpler stages to the more complex ones. The adults make use of the practical aspects of the context to shape their instruction style and thus move ahead opportunistically to transmit the traditional skills and knowledge to the novices in a very convenient and relaxed manner.

THEORETICAL BASE FOR THE STUDY

The following studies provided a base to undertake this research study. Evolution of cognition in human beings has always been an area of interest for the researchers due to wide variance in its existence. The results of studies done in the past and a motivation to probe the cognitive development of people situated in Garhwali culture were the driving force to undertake this study.

ACTIVITY THEORY

The activity theory was put forward by Russian psychologists namely, Vygotsky, Leont'ev and others during 1920's and 30's. By explaining psychology in terms of cultural activities and concepts, Activity theory drives cross-cultural psychology to the status of an explanatory science rather than a mere descriptive discipline. It says that human beings interact with their outside environment with the help of culturally available tools and other means. One of the basic ideas that led to the development of this theory was that there exists an inseparable relationship between conscious human mind and surrounding environment. This interaction guides a person's perception of situations and thus gives meanings to his ideas.

Vygotsky believed that cultural processes dominate the biological determinants of behavior in human beings. He explains psychological development thoroughly in socio-cultural terms, and not as something which has been partitioned into biological and cultural features. He rejected eclectic combinations of theoretical constructs. He said that psychological phenomenon originate in social interaction and are organized in social relations. Their constituents are social artifacts such as linguistic symbols. He however does not entirely reject the idea of a biological base for human behaviour. He considers that the biological processes are responsible for determining an infant's reactions. However their influence recedes as the social phenomenon dominates the influence on psychological phenomenon. He called this process as socio-genesis of psychological phenomenon.

The differentiation between internal and external activities is emphasized upon importantly in this theory. In the past, mental processes concerned activities that took place internally in an individual. But activity theory says that both the external as well as internal activities take place together in mutual co-ordination with each other. Both affect and get affected by each other in the process and this shapes the cultural norms of behaviour for a person.

In activity theory tools occupy an important place as it says that all human actions are mediated by tools. The activity theory helps us in understanding why the art of making tools or constructing houses etc. is specific to any culture. It is so because it is reflective of the experiences people have had in that specific environment while doing that particular work. During an activity itself a tool transforms and evolves as per the needs of the locals and thus carries with it the mark of particular culture. They are a useful means of acquisition as well as the transmission of specific cultural knowledge through generations' overtime.

Activity theory can thus said to be an incorporation of the notion of intentionality, historical background, social factor, and collaboration of both internal as well as external activities. It proposes that one cannot learn to use a tool without going into the details of the context and activity in which it is used. Therefore it emphasizes upon the idea of practice or doing an activity practically so that one can grasp the notional understanding of any tool or artifact and can aptly use it in different situations.

THEORY OF SITUATED COGNITION

Lave propounded the theory of Situated Cognition according to which cognition, perception and action of an individual lie within a social context. It means that social situation of a person is responsible in shaping the aforesaid activities. Lave got the guiding line for her work from John Dewey's belief according to which learning results from experience and social interaction. She was also highly influenced by the works of Vygotsky, Piaget and Bandura. The construction of knowledge within a social milieu while doing everyday activities has been emphasized upon in this theory. Uncontextual knowledge or bookish knowledge makes the child vulnerable in unfamiliar situations due to his inability to generalize the previously learned knowledge. Fluctuations in cognitive skills occur due to the situation and it suggests limitation in their generality. Each community generates certain norms or beliefs that are acceptable to all its members and

are religiously followed by them in their attempt to be a part of the group. The sense of belonging to a group persuades a person to behave according to the socially acceptable norms that makes his actions specific to his group culture.

The idea of Situated Cognition also defines a mutual relationship between an individual's cognitive evolution and his or her socio-cultural environment. According to it concepts evolve as a result of the perception of the individual and the activity undertaken by him as a result it. This evolution is a dynamic process that goes on continuously. The person's interaction with his surroundings creates meanings which are specific to his culture. The idea of Situated Cognition also defines a mutual relationship between an individual's cognitive evolution and his or her socio-cultural environment.

Situated Cognition does not confine itself to some areas but rather spreads over to the social; behavioral as well as the neurological perspectives of acquiring knowledge .It is aware of the cognitive powers of the individuals and thus states that cognition develops in individual's interactions with his social environment. Wilson and Myers (1991) also supported this idea and declared that Situated Cognition has a broad base comprising of psychological, anthropological and other learning theories and hence it aptly describes the learning mechanism in an individual.

Lave and Wenger in 1991 came up with a concept known as the concept of a community of practice (COP). They observed that in traditional communities knowledge is acquired by people depending on their age, level of authority, gender, status etc. This means that a newcomer is not inducted into the main activity at the onset itself. Rather he or she is required to go through different stages of knowledge acquisition prevalent in their society. These stages are in a hidden form but are very importantly to be followed by every newcomer. Under this a newcomer learns by moving from the periphery towards the center. This means that he moves from being a mere passive observant to a full-fledged performer in the social arena. They called this process as Legitimate Peripheral Participation (LPP). It is an informal way of imparting knowledge to the novices by systematically inducting them into the activity, from the introductory or simpler stages to the more complex ones.

Summarizing, Situated Cognition theory believed that learning is situated in the various everyday activities undertaken by people to meet their needs. These activities are contingent upon the social, cultural, ecological and other surrounding situations. Such type of knowledge is contextual and is acquired by actively participating in such activities.

COGNITIVE APPRENTICESHIP

John Seely Brown's work on Cognitive Apprenticeship was grounded on the notion that a person conceives the cognitive tools in the same manner as an apprentice learns his trade or craft. He takes inspiration from Lave's work on Situated Learning. In this model, social interaction and context in which learning takes place are extremely important. It marks the entry of the learner into a culture of practice, which ultimately leads to the development, and application of specific knowledge skills. Cognitive apprenticeship is an important means to instruct a person. It leads to better and permanent understanding of skills by the learner and also helps him in applying his knowledge in novel and unfamiliar situations. The expert or teacher guides the students in the introductory phase but withdraws as soon as he feels that the student has acquired necessary skills and is ready to perform the job independently.

NEED FOR THE STUDY

The present study derives its base from the aforesaid theories. Each of them contributed in its formulation in some way. The concept given in the activity theory that allows us to see all psychological phenomenon as a function of cultural activities and concepts form the platform for this study. On it the entire study was built, borrowing relevant ideas from the other theories. The contextual situatedness of any type of knowledge was put forward by Lave in her theory of Situated Cognition. It allowed the researcher to explore the cultural rootedness of the knowledge used by the community in this study while doing their everyday activities. Further, the concept of Cognitive Apprenticeship given by Brown, provided the ground to explore the ways through which local knowledge is transmitted in the traditional garhwali community.

The aforesaid relationship between culture and cognitive evolution motivates one to explore the social basis of knowledge. Theoretical evidences as well as the results of a number of empirical studies point towards the idea that the manner in which a person perceives, acts or thinks is indicative of the culture or the context in which it is situated. The same person acts differently in different situations because of the difference in the situational context. Because of lack of practical knowledge the person fails to apply the initially learned ideas in a new problem situation.

The strong impact of culture can be felt and seen in the overall personality of the individual. Dwelling units, fooding habits, clothing etc. almost all of the daily activities of people are dependent on the surrounding environment. Any attempt to see or study the cognitive development as a separate entity from the context in which it takes place is totally unacceptable from a researcher's point of view. Thinking is deeply rooted in one's culture and any attempt to separate the both would snatch away its specificity or cultural uniqueness. Folk wisdom help people to develop an understanding about the surroundings so that they may accordingly satisfy their needs with the judicious use of the available systems or resources. Thus it can be said that culture and cognition share a direct and inseparable relationship amongst themselves.

In the present study, an attempt is being made to explore the cultural situatedness of the local knowledge of the Garhwali villagers and also to elicit the hidden scientific concepts in their everyday activities. Sample activities like house construction, agricultural practices and tool making etc.were used for data collection in the study. The study is an attempt to move a step ahead in the endeavor to lessen the difference between the two types of learning, that is classroom and indigenous learning. Only then we can possibly succeed in utilizing the innate capacity of a child to reason and tackle an unforeseen situation in a better way. The state of mathematics education in our country needs improvement by reforming the conventional method of mathematics teaching in the classrooms. There is urgent need of adequate and appropriate induction of examples from everyday cognition, into the formal, classroom mathematics. It can serve the purpose of making the process of mathematics learning interesting and meaningful for the children even outside the school atmosphere. The indigenous communities throughout the world have managed to sustain their unique knowledge systems even through major upheavals. The sheer depth of this knowledge base can benefit all of us, from educators to researchers, to develop a more sustainable way of adapting to our surroundings. Therefore in order to avoid a state of frustration in the learner as well as the instructor, there is utmost need to assess the true worth of indigenous knowledge and use it in order to explore the implicit potential of the child.

CHAPTER 2- REVIEW OF LITERATURE

While studying the cognitive development in human beings one should be very conscious of the various factors affecting it. The manner in which they interpret the situation is responsible for the action they undertake and for this the context in which they are situated is very important. The relevant literature was reviewed in this chapter in order to identify the issues and questions that helped to design the present study. The studies have been summarized under different headings so as to explain the different aspects of the study.

CULTURE AND COGNITION

Psychology and meaning share a mutual relationship. This relationship has always been there since the time psychology came into existence as an independent discipline. However with coming up of newer schools the concept of meaning lost its place in the discipline. With the passage of time, that is, in 60's and 70's the importance of the idea was felt, as without it the human cognition resembled a computer program, which is devoid of any meaning. Bruner and other eminent researchers worked towards and succeeded in aligning meaning with the study of psychological processes.

Culture guides us through its socially approved norms in perceiving the surrounding environment in a meaningful and relevant manner. (Boesch, 1991; Kagitcibasi, 1996; Nsamenang, 1992). Without culture a person tends to lose his or her identity, as there are no rules to guide him to do the right behaviour and no norms to abide. Culture gives direction to our thoughts, perceptions, values and actions. It is a symbolic representation of the uniqueness and individuality of any community. Bruner (1990) described the importance of the folk psychology of 'signs, beliefs and behavior' in the process of imparting meanings to the actions of the people. According to him, it is a system or way, which helps people in explaining their various interactions, and experiences with the outside world and in this way create knowledge, which guides their

future actions. He also stated that the central concern of human psychology is meaning and the various processes and transactions involved in the construction of meanings.

The idea gets backing from the views put forward by eminent researchers regarding the social structuring of the child. Bruner (1996) is of the view that learning and thinking are always situated in a cultural setting and always dependent upon the utilization of cultural resources. The importance of culture is again emphasized upon in the writings of Vygotsky. According to him the individual and the surrounding systems interact in a coherent fashion so that each affects and gets affected by the other. Altman and Chemers (1980) suggested that people, cultures and physical environments form a social system.

Herskovits (1984), an eminent anthropologist, defined culture as 'the man made part of the human environment.' Brislin (1990) puts forward that home designs, layouts of villages; communities and cities, public building and places reflect the values and beliefs of a culture. Whiting (1964) has explained the causal influences of ecological conditions on the culture and personality development and hence behaviour. Houses created by people in different parts of the world differ on the grounds of design, materials used and the ecological context. Likewise, in the case of agriculture also, there is a wide variance in the types of crops grown, tools used for the purpose and the agricultural practices. This ability of human beings to adapt to its environment is exemplary and is also at the base of creating specific cultural environments.

The aforesaid studies convey the idea that there exists a clear relationship culture and the human mind. This idea gets backing from the Vygotskian idea of the social structuring of the mind. According to this, the individual and the surrounding interact in a coherent fashion to perform an activity. The cultural organization of human life is so intense that it regulates all the skills ranging from behavioral to biological as a phenomenon borrows more from the social cognition as against the psychological one. Different cultural prototypes exist for different cultures and this affects the cognition of the child situated in that culture. The differences exist between cultures because of the way in which we develop and concentrate on the different aspects of our environment and the different values and meaning we assign to them. In the past, academic intelligence reigned superior because of the popular view that it is universally applicable and can be

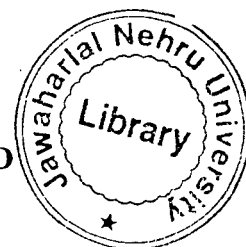
used in all the situations as compared to the practical knowledge, which is confined to specific contexts and thus lacks in generality. However this idea was opposed by eminent psychologists such as Ceci and Liker (1986), Goodnow (1986) and Scribner (1986) and anthropologists such as Lave (1988; 1990), who in their studies found that both academic and practical intelligence are interwoven in a social context. That means the socio-cultural background decides the form of both of them.

Shweder (1991) argued that the difference between a weed and a vegetable is not solely based on the edibility of the plants but it has also to do with our involvement with them. He gave a good example of seaweed, dandelions etc. which are considered as a weed in France whereas in Korea they acquire the status of a vegetable. Similarly in our country which has a vast diversity of cultures such examples can be easily seen.

If we do not take into account the contextual base of cognition, then we are limiting our expanse of knowledge.

TH-12562

LEARNING AND SITUATION ARE INTEGRALLY RELATED



The way each community frames the tool and uses it is a direct indication of the way community members perceive their surroundings. The way they act in certain situations reflects their thinking style. It is possible that we know the basic idea of using a tool but in different socio cultural contexts, its application may be entirely different. That is why different communities use tools in a different manner. The same applies for the conceptual tools as well which indicate towards the cumulative wisdom of the culture and the inhabitants.

Individuals have been found applying different types of logical and mathematical reasoning in school than at play or marketing. School woodwork is not carpentry and similarly the sewing done in art and craft class does not make the student a tailor. It is because, these activities are inevitably separated from all the social elements, needs, goals and so on, which make tailoring and carpentry a professional art.



Nsamenang (1992) emphasized that every culture offers to its members a specific way of perceiving the surroundings, which guides them in all their actions. Every human mind develops in a cultural context. This cultural context affects the learning process of child and eventually his actions. Levine et al in their study in 1994 supported this idea with the example of Sub Saharan Africa. This community provides specific cultural patterns to all its members thus shaping all their actions and behaviors. The people in this community have their own perceptions of their ecological environment and subsequently they conceive ways of adapting to it.

In yet another example of cultural specificity, Maquet (1972) differentiated between the concept of universal humanity and specific individuality. He says that the culture wherein a person stays marks the formation of a cultural zone, which is different from one culture to another. That means it has the features, which are specific to one culture. Researchers like Brainerd (1978), DeLoache and Brown (1979), Feldman (1980), Siegler (1981), Rogoff (1982) have emphasized that the context in which cognitive development takes place is very important. Without a context they notice a lack of generality of capacities in their studies.

Lave (1996) stated that context is an active component of any activity and it is therefore mandatory for all researchers to do their studies on cognitive development in its contextual relation. Gladwin (1970) in a study on Micronesian navigators found that they showed good memory, inference and calculative powers when doing their regular traveling from one island to another but performed very badly on standard intelligence tests.

It has been generally seen that the formal knowledge imported in the school is not of much help in real life situations. It is so because this knowledge is deeply rooted in the school culture. Lave (1988) in her study of learning and everyday activity said that a great difference exists between the cultural activities and the knowledge that the students get in school. Resnick (1987; 1990) differentiated between the two types of learning namely-In school and Out of school learning .He stated that school learning was based on an individual's cognition, thinking and other principles of teaching. Whereas in real world situations learning takes place on the basis of shared cognitive ideas of the

community in total, its various practices to adapt to its surroundings and other such situation specific activities.

Contextual setting helps in expanding the scope of psychology as a discipline as now, we are able to explore human thinking as a product of both an individual and his/her socio-cultural, anthropological and political contexts. Folklore, mathematics, science, language all help in the conception of symbolic systems of knowledge construction which help a person in thinking and acting with regard to the activity and are so situation specific. This research finding by Carraher and Ceci (1997) supported the previous findings and concluded that there exists a mutual relationship between learning and the situatedness of an activity.

Knowledge can be called as a reflection of the situation in which it arose and was used. It gets its form and meanings from the different circumstances that came across the person while solving any problem. Labov (1970), Cole (1975) and Scribner (1976) came up with the idea that the persons who performed miserably in the logic or communication problems in test conditions, came out with better results in more familiar contexts.

Thinking can be called a practical activity, which is created in the individual's adjustment to his surroundings. Suppose a well-educated person with zero level of practical knowledge is asked to work in a shop. He may not be very efficient in carrying out this job. It is not so because he does not have the necessary skills, but, because doing a job practically requires experience rather than a systematic, formal bookish knowledge. Pea (1988) and Hutchins (in press) support the situatedness of cognition across physical as well as social environment.

This can perhaps provide some explanation for the individual differences in performance of the various mundane tasks. Other than familiarity and linguistic resources, one very important problem the child may face is in visualizing the problem from the periphery. Culture to us, may seem as a guideline to the thoughts, feelings and behavior of the people living in. But if we delve deep into it, then we get to know that culture is the very base and platform for the perception, thinking and actions of its people. The socio-cultural approaches have highlighted the importance of situation in the learning process. Lave (1988) in her study of shopper's best buy strategies stated,

”cognition is constituted in dialectical relations among people acting, the contexts of their activity and the activity itself.”

Substantial evidence is provided to us from the works of Vygotsky, Luria and Leont’ev alongwith the work on activity theory which says that the way in which individuals act, think and behave is contingent, to a large extent, upon the socially available and acceptable tools .The type of tools available in a social context and the way they are used comprise the local knowledge of that particular community which assist to maximize the level of satisfaction & their efficiency in using that tool.

According to Leont’ev (1978) these tools or artifacts such as notational systems, physical and computational tools and work protocols are named as ‘crystallized operations’ which are borne out of needs within a given social milieu and in turn shape and restructure future practices. The results of these studies provide some explanation for the individual differences in performing the various mundane activities.

Thinking, thus can said to be related to the context in which the problem and the problem solver are situated. This context comprises of the physical and conceptual structure of the problem along with the purpose of the activity and the social structure in which it is situated. This provides support to the idea that knowledge is organized intellectually, that is, structured and formalized, subjected to the specificities of cultural nature and through the cultural process of sharing knowledge and according behavior, it is socially organized.

EVOLUTION OF MATHEMATICS AND SCIENCE AS A CULTURALLY SPECIFIC KNOWLEDGE

Cultural protocols are very important especially in the area of science and mathematics learning. Till 1950, there was an understanding that mathematics is a culture free and value free discipline. But recent research findings in both anthropological as well as cross-cultural studies reveal that mathematics has a cultural history.

Mathematics plays an important role in the everyday activities of people, as we tend to use it in some form or the other in daily routines. Because of this characteristic feature, it has become an important and popular area of interest among the researchers. Research evidences from the various anthropological and cross-cultural studies support the idea that mathematics has a cultural history. What emerges from different cultural histories is nothing but different form of mathematics. Zaslovsky (1973), in her book '*Africa counts*', has shown the range of mathematical ideas that exist in indigenous African cultures. Van Sertima's *Blacks in Science* (1986) is yet another African source as is Gerdes' (1985). On other continents, the research of Lancy (1983), Lean (1986) and Bishop (1979) in Papua New Guineas, Harris (1980) and Lewis (1976) in Aboriginal Australia and Pinxten (1983) and Closs (1986) with the Amerindians, has also fuelled this debate. D'Ambrosio in (1984) stated that the manner, in which a cultural group creates its own norms, beliefs and other symbolic representations of knowledge systems decides the way in which they mathematise their problems and also interpret them.

D'Ambrosio in 1985 in his ethno mathematical program says that ethno mathematical activities are anthropological in nature primarily because it tries to elicit the embedded scientific and mathematical concepts in the everyday activities. The past experiences and their evolution with time decide the mathematical history of an existing practice. The term '*ethnomathematics*' refers to the mathematical ideas, which are specific to a community or group. Each community creates its own scientific ideas in its attempt of survival in its surroundings. These ideas have embedded mathematics and scientific concepts, which guide their actions and behaviour. Mathematics in everyday practices such as weaving and house construction etc. is hidden. Gerdes (1988) expressed the need to decipher or 'unfreeze' such mathematical practices. Even though presently these activities may seem to be unscientific in nature as people follow them without any logical understanding But in the past when these activities were conceived then surely it must be on the grounds of some sort of scientific understanding of the natives regarding their surrounding environment. As a result of this, the idea emerged that mathematics can indeed now be taken as a form of cultural knowledge, which is generated specifically by each culture, even though it may not be the same from one cultural group to another.

According to Lave (1977), one should not view mathematics as an abstract quantitative activity but as something deeply bound in socially organized activities and systems of meaning within a community. Bishop (1988) in his paper “Mathematics education in its Cultural Context” has referred to mathematics as a ‘Pan –human’ phenomenon. Way back in 1959, White gave the most powerful starting point to the debate on social nature of Mathematics by calling it a cultural phenomenon in his book ‘*The evolution of culture.*’ He believed that culture played the dual role of relating man to his environment on one hand and of relating man to man on the other. To explain this process he divided culture into the following categories, namely, 1) ideological 2) sociological 3) sentimental and 4) technological. He put forward that all of the four are interrelated with technological factor determining the form and content of the other.

According to Nunes, Schliemann and Carraher (1996) the ability of a person to deal effectively with the mathematical problems depends on his conceptualization of these ideas and the various terms and symbols used in the process. They considered that the mathematical concepts learned in the process of doing an activity in real world situations are more helpful and have more practical applicability. It is so because such type of learning is situated in proximity to the real life situations and thus the learner feels freer in relating to it.

Bishop (1986; 1988) contented that the manner in which each cultural group generates its own language; religious belief etc., in the same manner these cultural groups generate their own mathematics. According to his analysis, there exist six fundamental activities, which according to him are universal as well as extremely important for the development of mathematical knowledge. He intends that mathematics, as cultural knowledge, derive from human beings engaging in these six universal activities in a sustained and conscious manner. The six activities are Counting, Locating, Measuring, Designing, Playing and Explaining.

Counting is an orderly manner of comparing and discriminating between different phenomenons. Shipley and Shepperson (1990) have referred to the unlearned social abilities, which according to them aid the children in counting which initially starts as a meaningless activity. These unlearned activities are nothing but the child’s experiences

with the numbers in their respective contexts, which the child applies, in his future problems.

Locating refers to the various models, diagrams, drawings, words and other means used by people in exploring and then conceptualizing and symbolizing their spatial environment. P.R. Dasen, R.C. Mishra and A. Vajpayee (2004) in their work on spatial encoding have mentioned that the knowledge about one's space can be had both through direct means, namely self exploring such as walking, running, driving etc. or indirectly through the various social and cultural norms and practices passed on by the parents to the children. The manner in which the environment is perceived or interpreted is contingent upon the child's experiences within his or her particular culture. Even in our everyday activities we have different cues while moving out or locating some place. All these cues owe their existence to the contextual situatedness of the individual.

Measuring is a way in which one uses different objects or units as a measuring device so as to quantify the objects for further comparison and ordering. Researchers such as Siegel (1977), Cole, Hood and McDermott (1978), Gelman (1978) and Rogoff (1982) have emphasized the role of context in cognitive activities. The aforesaid examples lend support to this view as they reveal how people rely on their traditional knowledge and wisdom in their day-to-day transactions. People's social relationships give structure to their activities.

Lave (1984) has called the various systems of measurements, along with algorithmic and arithmetic as well as different currency systems, as a highly subjective experience. According to her, the problems are a type of subjective experience for people who get motivated to solve them and hence what results is more of a type of enduring resolution rather than exact solutions. Money management practices are an apt example of how the standard, universal knowledge is shaped according to the context and situation based forms and measures of quantification. Bohannon (1955), Polanji, Ainsburg and Pearson (1957) have reported an anthropological work on primitive cultures where beads may be exchanged for pigs and iron bars for women, however this exchange process was not applicable vice-versa and also could not be termed as universal. It was in complete contrast to the monetary system prevalent in Western cultures, which provided a more universal and standard mode of exchange through currency notes and coins.

Designing provides a symbol, design or shape to any object or any other thing that is a part of one's spatial environment. The way people construct houses, make various tools, utensils, other goods etc. shows a culture and situation specific mark. Aggrawal and Shah (2001) in their study on the Earthquake Resistant structures of Himalayas found out that during the Oct, 1991 measuring 6.6 on the Richter scale, more than 425,000 people of about 2,100 villages in the districts of Uttarkashi, Tehri and Chamoli in Garhwal Himalayas were affected. Traditionally built timber houses proved to be the most effective at keeping damage at bay. It would, however, be unwise to say that the old-fashioned houses survived just because of materials used. The construction techniques, on a large scale, determined the amount of damage. During an earthquake, buildings collapse as a result of inertial forces. The lower part vibrates due to its proximity to the ground whereas the upper portions remain static due to the forces of inertia. Due to the conflict of forces, the building comes down. The prevalent traditional house construction pattern in Garhwal is considerate towards this idea and thus uses big boulders and stones in the lower part. This practice keeps the house safe during occurrence of an earthquake.

In the views of architect by Das Gupta (1999) avoiding compression structures like domes, vaults and arches is one way to lessen the damage. It also helps if the structure is constructed in a way that it vibrates as one unit and sways together. It has been found that the traditional construction in India's northeast as well as the tall skyscrapers of Tokyo, Japan follows this principle due to their being located in a high seismic zone. They use traditional or modern means of construction as applicable and try to build the structure as a compact one unit. One can even notice their swaying in the case of a blowing of a strong wind. Natural hazards are perceived, interpreted and represented by local communities in culture –specific ways relating to their relation with the surrounding environment. The way, in which they perceive and interpret, marks the way local communities deal with the hazards through their local, common and unique practices for survival.

Playing is a formalized set of rules to be followed by the players in games and pastimes. No substantial literature was found on this activity but while exploring the activities in the villages in Garhwal one comes across their indigenous rules and procedures for playing cricket, which has its own universal rules. The idea being conveyed is that the

practices are generated, organized and transmitted informally to satisfy the immediate needs of population and this what constitutes the popular culture.

Explaining refers to the manner in which people account for the existence of certain religious, social or scientific practices prevalent in their society. Bishop (1989) has proposed that by engaging in the aforesaid six universal activities, a person can create some basic notions, which can form a basal structure for western mathematical knowledge as well as that of other cultures. The concentration of mathematical activities based in their specific cultures is very aptly explained by Lancy (1983) who came up with a 'universal' stage theory of cognitive development. According to this theory, stage 1 corresponds to the Piaget's sensory-motor and pre-operational stages. It says that "what happens to cognition during this stage 2 is much dependent on the culture and environment rather than on genetics." Bishop thinks that this stage 2 is the one where different cultures develop their own specific mathematics.

Practices, therefore, should be seen as discursive formations within which what counts as valid knowledge is produced and within what constitutes successful participation is also produced. Lave and Wenger (1991) mention that, "participation in the cultural practice in which any knowledge exists in an epistemological principle of learning." From the discursive, cultural point of view, learning is an initiation into social practices and the meanings that are part of those practices. Activity theory, developed initially by Vygotsky, Leont'ev and Luria (1978), claims that "all activity is socially mediated and that consciousness is located not in the head but in practice. This idea was propounded by Nardi in 1996. It emphasizes that the development of understanding in an individual regarding any activity or tool use should always be rooted in a context. This makes the acquisition of knowledge permanent and practically applicable by the person in new situations. Vygotsky (1998) advocates participation in different life practices by the individuals as believes that one cannot undergo cognitive evolution by aping or modeling.

Kula (1986) provided evidence that the realistic nature and functions of the traditional methods used for qualitative measurement restricted historians from shifting to the modern 'conventional' systems. These methods are grounded in realistic practical

experiences of the natives with their surroundings and hence are more meaningful to the users.

A study was done on the members of a rural community in northeastern Brazil by the researcher De Abreu et al in 1989 to find out the level of notional understanding of mathematical ideas among the teachers and students in that particular society. She explored the important economic activity of sugarcane cultivation in the region. The results revealed that a lot of mathematical ideas exist in this activity though in a hidden form. They used these indigenous methods in measuring the land, paying the laborers etc. Because most of them were illiterate so they could not articulate their knowledge aptly. But as per the popular convention even these people thought that their knowledge was not as scientific as the popular western knowledge system.

Among the Indian studies, we can take the example of Panda (in press) who in her paper presented in the conference on 'Cognitive sciences', Paris has talked about her ethnographic work done on the Saora tribal villagers of Orissa. In her study she has examined the traditional activities of Saoras in order to find out the implicit scientific, physical and mathematical concepts in them. In her work, she argues about the as-if assumptions and their relationship with the available cultural prototypes and ecological conditions. Her findings reflect the situatedness of these concepts in a particular context, which result from the discursive exchanges that take place between the available resources. Rampal (2003) in her article 'Counting on Everyday Mathematics' has attempted to explore the rich oral and indigenous knowledge system of India. She expresses her concern over the poor state of mathematics teaching in schools. As a result of her study she emphasizes the need to consider the importance of traditional knowledge and club them with classroom learning practices so as to make the process meaningful and fruitful for the learners'.

Cognition is seen more of as a complex social phenomenon as against the psychological one. It is distributed or stretched over and not divided among mind, body, activity and culturally organized settings. Lave (1988) After analyzing the aforesaid six universal activities by Bishop, we can accurately say that indeed knowledge is socially or culturally based to suit the needs and expectations of the inhabitants. Knowledge

emanates from the people, essentially generated by the individual as a result of man's drive immediate environment and in permanent change as a result of man's action.

Children's mathematics learning can thus be seen as an action, constructive and culturally specific social process. The reason why mathematics can be a good research topic in cognitive psychology is that it has a highly structured and incorrigible vocabulary and hence can be easily recognized in the course of ongoing activity. Jean Lave (1984) in her book 'Cognition in Practice' says that mathematics itself should be seen not as an abstract mathematical tool but as something deeply bound up in socially organized activities and systems of meaning within a community. Therefore, the trade or art which the children learn in the school atmosphere is very different from the work done by the professionals in those areas not inevitably separated from all the social elements, needs, goods and so on which are a part of the work practice of carpentry. It is found that individuals may employ different kinds of logical and mathematical reasoning in school, compared with at play or shopping. These aforesaid statements convey the idea that whether it is a Cognitive or a Socio-Psychological research, the researcher should make it a point to study the everyday knowledge, its content, structure, function and its social constitution.

TRANSMISSION OF TRADITIONAL KNOWLEDGE TO CHILDREN

An extremely important question that comes up is that how is the traditional or everyday knowledge acquired by the individuals. Scribner and Cole (1973) pointed out that children in modern societies characteristically take training in places like schools, away from the real adult world whereas the children in traditional societies learn the art by apprenticing adults in real work situations.

White and Siegel (1984) in their article on '*Cognitive Development in time and Space*' mention that children in a community extend their knowledge of the distant by specializing in specific areas. For example, children who opt for farming learn more about crop loans, commodities markets, agricultural policies etc. Whiting () found that the

power of parents and other socializing agents to shape social behavior lies largely in their role in the arraignment of children to setting. Each setting has its own peculiar group of people, are activity in progress, physically defined space and some typical norms of behavior the blue print for propriety in these settings.

In many traditional societies, girls are not allowed much outside access and are made to stay in their homes with old people who demand respectful and nurtures kind of behavior. Boys, on the other hand, are placed with like-age children, who call forth competitive behavior. Such contrasting settings account for the different types of personality developments among boys and girls. Much of the parent child interaction may be subtly structured in ways that promote development of social and cognitive skills in children, without the explicit aim of instruction in the adult's mind.

Extending his description of a development sequence in his study of the Kipsigis system of traditional education in Kenya, Koech (1974) states that first of all the child starts observing the activities. His/Her participation in that activity starts though at a small level and then eventually the child graduates to perform the task independently. Lave has termed this as learning by Legitimate peripheral participation (LPP) where the child is situated at the periphery of the activity slowly he rashes is takes first assigned small apprenticeship tasks and eventually they picks up the final job. In a way it can be said that it all depends on the contextual setting in which the person and the activity is based.

Rogoff in her research findings in 1995 assessed learning as a continuous activity and for this used the term "participatory appropriation". This explained learning process in human beings as a process of active participation in the activity situated in a specific context. The past plays an active role in it as it prepares the ground for new learning to take place.

D 'Andrade (1981) mentions that children may very rarely be independently responsible for identifying the connections between problems or associating available knowledge to fit new problems. *Laboratory of Comparative Human Cognition* (1980) credits the adults for facilitating child's learning process by regulating the difficulty of the task, making available well-placed guidelines and a display of expert, mature performance. They place their set of instructions in a well-explained context so that it is

easier for the child to relate his/her previous learning to the new and novel experiences that come their way.

Fortes (1938) made the following statement about education in traditional, non-industrial societies. According to him the training of the young in a community is seldom regularized or systematized, but occurs as a 'by-product' of the cultural practices. We fail to come across any such situation in a traditional society routine, where formal & systematic arrangements are made by the elders to impart the local cultural knowledge to the young ones. It is more of a trial & error process to develop understanding about the various traditional activities among the inhabitants. This form of knowledge develops through practice, which signifies a systematic approach to acquisition of knowledge in an entirely informal context.

Kula, (1986) and Wade, (1949) objected to the use of the word 'conventional' for traditional knowledge. According to them traditional knowledge is deeply rooted in social context and is acquired by people through active participation. It therefore has an embedded meaning which truly explains the activity in detail. They instead called the modern metric system 'conventional' owing to its detachment from the social context.

The structuring of the instruction serves as a scaffold for the learner, providing a framework for the solution to the problem. A novice mostly acquires skills and knowledge in an informal manner by keenly observing an expert while participating at a comfortable but slightly challenging level. The child actually performs the task under expert guidance, thus participating in creating the required contextual knowledge for the task and in this way acquires some of the expertise from the adult regarding the problem and its solution.

In a study on Vai and Gola tailors (Lave, 1988) it was found that initially the apprentice tailors were asked to iron finished garments. It is not that they are being considered inferior but it was a gradual way of introducing an idea to them because while ironing the apprentice would closely notice the different cuts and folds. This would informally give him the basic idea of tailoring.

One example of the educational process used by the Guarenos of the Orinoco delta of Venezuela is given by Ruddle and Chesterfield (1978) which they use to teach cultivation, animal husbandry, hunting and fishing to the children and novices in their

community. This mode of instruction is highly systematic with different instruction styles although the implicit aim of teaching remains hidden. The children learn in an informal atmosphere without any nervousness that they are being forced to learn any art.

The traditional vocational educational system of the Guarenos is very structured and systematic in nature, with emphasis on the 'learning by doing', which is through repeated practice over time rather than being a passive observer. Initially, they induct the child into the task by familiarizing him/her with the basic elements. The entire procedure is demonstrated systematically, moving from simple to complicated steps. When finally the child is able to work independently then the teacher or the adult withdraw from their role of an instructor thus allowing the child to himself/herself take charge of their life and actions. Similar technical training takes place in Wogeo, New Guinea where the various skills are acquired mainly through direct participation in everyday tasks. The child may watch. The adults or the experts for the initial stage and can eventually take over when they are familiar with the working style.

Lambert's (1986) multiplication teaching style to her students was connected with their everyday knowledge. She tried to make it interesting by incorporating certain anecdotes from their real life practices. The students gained a lot and also she was able to connect the knowledge and the problem solving activity. In other words she was able to bring together the two concepts of knowing and doing. This method allows the students to develop more faith in their implicit knowledge as they know feel that it can also be used in real life situations.

Cognitive Apprenticeship teaches in a situated manner (Collins, Brown & Newman, in press) thus making the knowledge more accessible and understandable to the learner. Legitimate peripheral participation (Lave & Wenger) also is an interesting and important method of teaching whereby the learner does not take part initially and tries to grasp the information from the periphery. This learning style is important for the beginners from the economic as well as psychological point of view. Firstly, they will not waste or damage any thing and secondly they will not get that nervousness that on the first take they will be asked to work. They are very clear that this initial introductory phase will give them enough information about the work so as to make them confident

when they actually do the work. Therefore they observe the adults for a while and then without any encouragement try to imitate them as best as they can.

Fortes (1938) commented about imparting of education in traditional, non-industrial societies. He reported that these societies did not have any systematic or regular pattern of training the young ones. Rather it took place in the regular cultural routine. Lave (1988), Nunes, Schliemann and Carraher (1993) found that even school imparted knowledge is not universally applicable and hence it is in no way superior to the everyday knowledge which carries with it a socially constructed meaning and is more applicable in practical situations.

SUMMARY

A review of literature on culture and its relation with the cognitive evolution of the child shows that culture plays an extremely important role in giving us an identity of our own and thus helps us to shape our ideas, thoughts and behavior.

It is seen that individuals differ in the performance level and styles according to the context and situation where they are based. It is found to be better in everyday conditions as compared to formal, testing conditions. This is backed by a number of researches done on “everyday cognition of people.” Various studies done in the past show that learning depends on the availability, relevance, utility, and social acceptability of any object, tool or idea in a particular setting.

Cultural symbols and protocols play an important role in ethnomathematics and ethnosciences. Studies have shown that even science and mathematics have a cultural history of their own. Knowledge comes coded by and connected to the activity and environment in which it is developed and is spread across its component parts, some of which are in the mind and some in the world. The occasions and conditions for the use of a tool arise directly out of the context of activities in which the natives use it. The tool framed by the members of that community reflects the way in which the community members perceive or see the outside world. Thus, carpenters and cabinetmaker use chisels differently.

Studies have also shown that the traditional knowledge is transferred or passed on from the adults to the children through the means of legitimate peripheral participation and cognitive apprenticeship. Firstly, the individual starts from the basic and simple steps and then eventually moves towards the more complex ones under the expert guidance of adults.

A review of the history of evolution of metrological concepts lead to the finding that in the beginning the development was 'anthropomorphic'. It means that during this period various body parts were used as different units of measure. People used palm, fingers, hand etc. as units of measurement while constructing their houses, ploughing their fields etc. The traditional system of weights and measures was based on a qualitative approach as it differentiated between different quantities of a commodity on the basis of the differences in their quality level. The one, which was of coarse variety, was given more in quantity in exchange for a good variety of commodity. The Chinese system kept the cultural background of cognitive evolution in mind while deciding on their metric system as the people were more comfortable with their traditional units of measurement hence the government decided to use the same terminology but standardized them as per the modern conventional measurement units .The past familiarity of the people with the names of the units made it easier for them to adopt the new system and also to the government to overhaul the existing system.

A revised version of socio-cultural explanation of psychological phenomenon by Vygotsky asserts that individual development should always be analyzed in its socio-cultural context (Yong 1992). Also, children's mathematics learning can be seen as an active, constructive and a culturally specific social process. It means that child's learning process is not entirely a cognitive phenomenon rather the social factors from one's own background co-produce learning and cognition.

Thus, it can be said that cognitive evolution takes place in an individual under the expert apprenticeship of the adults situated in a particular cultural context. So while doing any type of research on cognition, one should always keep in mind the social, psychological, ecological factors that are important in its development. The question that now crop up is that if the informal traditional knowledge system is so important then why our policy framers have failed to incorporate it in our teaching practices? Keeping in

mind the importance of situated cognition, as concluded by the review of aforementioned studies, the traditional knowledge should have been an integral part of our school system but it is not so. Then by ignoring it, are we not creating a farcical education system, which is far away from its goal to provide comprehensive and applied knowledge to the learners? There is need for us to adopt a broader perspective of looking at mathematics and develop innovative and effective mathematics teaching strategies in the classrooms. Keeping in mind the socio-cultural nature of mathematics will motivate us to appreciate its inclusion in our classroom atmosphere so that the learners can get educated in the real sense.

CHAPTER 3-METHODOLOGY

Traditional cultures are expected to exhibit specific forms of local knowledge that consists of ideas and practices that allow one to understand and manage nature in a sustainable way. Culture can be called as a process of production and reproduction of meanings in a particular actor's practices or activities in particular contexts in time and space. In this study an attempt is being made to examine the scientific and mathematical notions implicit in the traditional cultural wisdom of the Garhwali villagers in Uttaranchal. These villagers have their own ways of doing mundane jobs, which develop as a result of their continuous interactions with their environment. Even though the villagers may not be able to articulate using scientific terms but they possess traditional knowledge required to carry out a task. The following study is a step towards exploring the everyday activities of Garhwali villagers in search of the implicit cultural wisdom in them.

PROBLEM STATEMENT

Man continuously explores his surroundings and acts on them in order to make his life functional and comfortable. In this process, he/she systematically acquires skills and equipments, which he produces and applies in his dealings with nature. All such locally conceived knowledge is collectively invented and the same is passed on to the younger generations through active participation in these culturally produced activities. There is a need to find out how much these constructs are socially or culturally based? Attempts will also be made in this study to discover the implicit scientific and technological know how in these intellectual constructs?

RESEARCH QUESTIONS

This study is an attempt to find out -

- . How the people in Garhwali community in Uttaranchal develop the notional understanding of mathematical and scientific concepts while doing their everyday activities?
- . How does the surrounding environment affect their conception of the idea of age, time, distance etc.?
- . How much has the modern technological development change their ways of performing their everyday activities and therefore their everyday cognitions in the area of mathematical and scientific concepts?

- . How do they think their way of doing everyday activities is specific to their region?
- . How do the elders/experts transmit their expertise to the future generations or novices?
- . What role do girls/women play in each of the activity vis-à-vis men? In other words, how much importance is given to the decisions of women in Garhwali communities?

RATIONALE OF THE STUDY

The review of the literature indicates significant differences among individuals from different cultures in the performance of the activities. Different cultural prototypes exist in different cultures that affect the cognition of the child situated in that specific culture. Cognition is therefore seen more of as a complex social-psychological phenomenon as against the psychological one. In order to survive, man needs to generate ways to deal with the immediate environment that provides him or the requisites needed for survival. These practices eventually produce knowledge which members in a community have and pass them on to the next generation. This specific local knowledge that binds a group of people, community or society together constitute the culture.

Eminent Researchers (Boesch 1991, Kagitcibasi 1996; Nsamenang 19 92) have pointed out that culture provides us a base for perceiving what is meaningful, relevant and salient. The impact of culture on our lives is so intense that it affects even our supposedly the biological skills of eating and walking. That is why different cultures have different eating habits, and so on. Something, which is considered a food item in one culture, may be taken as a weed in another. The differences exist between cultures because of the way we develop and concentrate on different aspects of our environment, and values and meanings we attach to them. The available resources, ecological conditions etc. shape the cognition of the individual. The person tries to adjust to his or her environment in the best possible manner so as to make the most out of it. Dwelling units, food habits, tools, religion, folklore etc. are important examples of such practices and constitute the culture of that community.

In the past, psychologists (Bronfenbrenner & Mahoney 1975, Neisser 1976, Cole, Hood & McDermott, 1978) have expressed their doubts on the ecological validity of the experimental findings and have come up with questions regarding what thinking is like in the pervasive contexts of peoples' lives. In Mid 70's, both the cognitive psychologists and the cognitive anthropologists shared a functionalist position as an answer to their problems about culture and cognitive processes. It was based on the idea that society is a set of macrostructures in places and the individuals residing there

Everyday knowledge occupies an important position for research in social psychology. Social Psychology allows us to systematically study the effect of the culture on the experiences of an individual. The importance of everyday knowledge has also been emphasized upon by a Neurobiologist Francisco Varela (1990) who in his research came up with the finding that correct understanding of cognition cannot take place without taking into account everyday knowledge which comprises of the physical and social history of any group or society.

Every community generates specific knowledge in the area of science and technology, which is used to solve everyday problems the community, encounters. The reason being that local technical knowledge is based on the practices and perceptions as conceived by the people in their effort for survival. One way of studying human mind effectively is by examining the everyday activities. Recent research findings have stated that mathematics has a cultural history. It means that every culture has its own original mathematical ideas just like its own language, culture, beliefs etc.

This study is an effort to find out how do the Garhwali villagers develop knowledge or understanding of the various scientific and mathematical concepts involved in their everyday practices. These practices help in making their lives comfortable and convenient in the arduous and difficult hilly terrains. This study can be of great help in helping us to know about the implicit mathematics and technology in the popular local knowledge of the villagers. The findings can guide the policy makers in formulating such plans and policies for these people which can benefit them the most.

OBJECTIVES OF THE STUDY

- 1) To study the scientific and mathematical concepts embedded in the everyday cultural activities of the Garhwali villagers.
- (2) To explore the level of notional understanding of these concepts among the villagers and to analyze the role of cultural practices and ecology in the formation of these physico-mathematical concepts.

SAMPLE

The present study was conducted in the Sumari village of District Pauri Garhwal in Uttarakhand. The attempt was to find out the embedded scientific and mathematical concepts in the everyday cultural activities of the Garhwali villagers. Since sample activities like house construction, agricultural tools etc. were to be observed as a part of this study, all those persons, adults as well as children, who were in any way a part of the sample activities were included in the sample for this study.

INTRODUCTION OF THE GARHWAL REGION IN UTTARANCHAL

The Himalayan range extending in northern part of the country is known as Uttarakhand. This was previously a part of the larger state of U.P. But, after a long struggle for self-representation, it became a separate state in November 2000. The region comprises of two hill zone- Garhwal and Kumaon. The Garhwal Himalaya covers an area of 14,565 square miles and has 4,724 villages. After the British occupied the region, it was divided into British Garhwal and Tehri Garhwal. In the Garhwal region, the Ganga, Yamuna, and many other rivers and rivulets are seen in their blissful infancy. The region also has a galaxy of peaks and glaciers, meadows and valleys. Garhwal, the land of infinite mountain, lakes, abundant floral scapes and its fauna is known as 'Abode of gods'.

INFORMATION ABOUT THE VILLAGE

Village Name	Sumari
Block	Khirsu
Patti	Kattuulsiu
District	Pauri Garhwal
State	Uttaranchal
Located at a distance of approximately 25 Kms. from Srinagar.	
Height above sea level	1370 mts.
Area	203.23Hectares/10,150Nalis
Total population	572 people
Number of Males	260
Number of Females	312
Total Number of Scheduled caste families	70
Literacy rate in the village	73%
Total Number of literate persons	338
Number of literate males	219
Number of literate females	199

A VIEW OF SUMARI VILLAGE

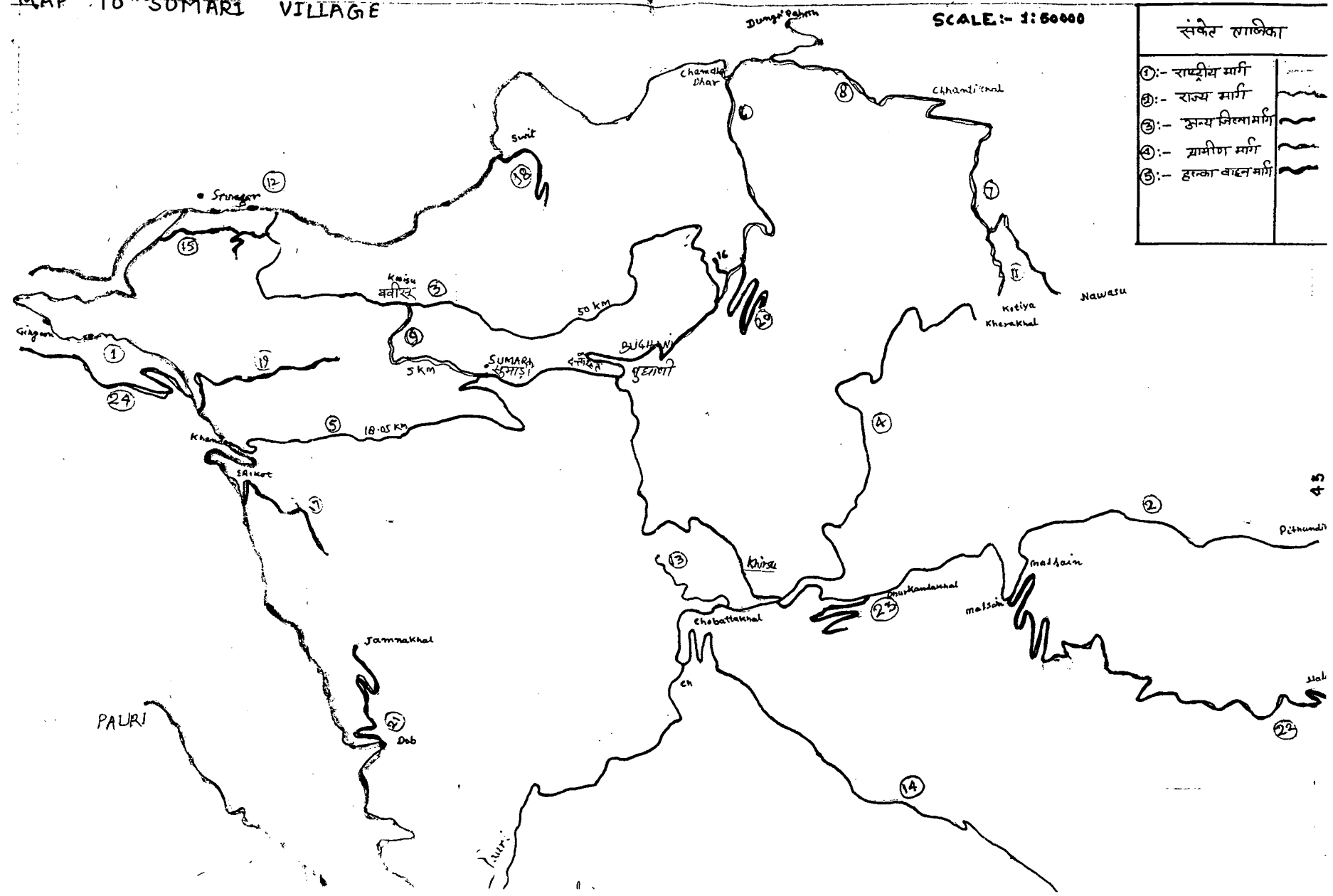


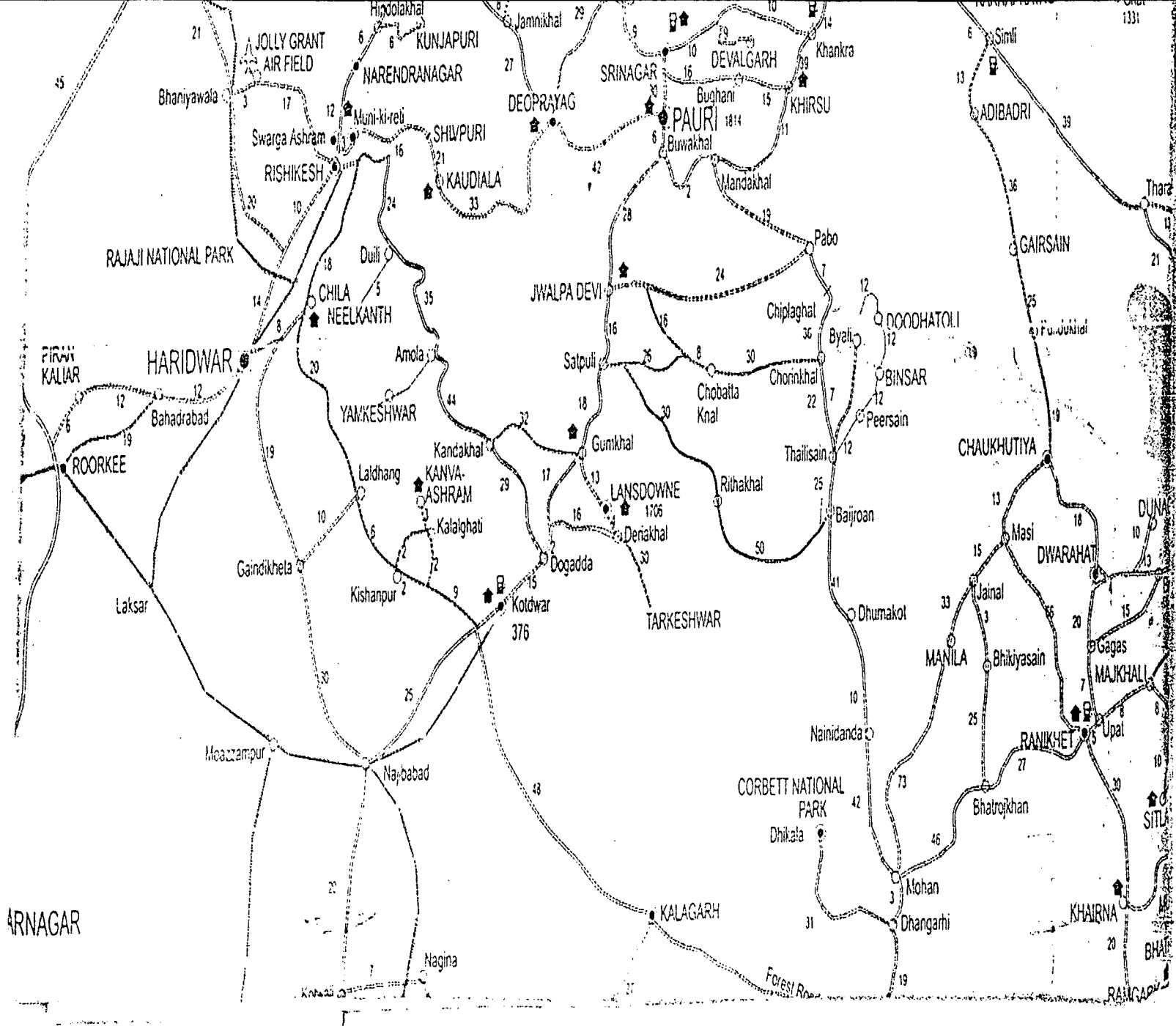
MAP I: ROAD MAP TO SUMARI VILLAGE

SCALE:- 1:50000

संकेत तालिका

- ①:- राष्ट्रीय मार्ग
- ②:- राज्य मार्ग
- ③:- अन्य मिला मार्ग
- ④:- ग्रामीण मार्ग
- ⑤:- हल्का वाहन मार्ग





MAP NO.2: SHOWING THE LOCATION OF SUMARI VILLAGE IN UTTARANCHAL

Uttaranchal state comprises in all, thirteen districts, out of which, six constitute Kumaon division and the remaining seven are components of Garhwal division. They have been further divided into 49 tehsils and 95 development blocks in the year 2002. From early times, geographical factors have been very important in shaping the history and culture of this region. The successive phases of folding and uplift of the Himalayas, created new dimensions in the studies of global mountain system as well as the evolution of human civilization. The climate of the state is quite different from other parts of the country. It differs from place to place due to geographical differences. Altitude is an important factor which influences the climate of the region. Different ecological zones favor the growth of specific crops. People plan their lifestyle accordingly so that they are able to meet their basic needs by themselves. The hill people are basically a cooperative community, where every person is ready to help the fellow villager in his works and in this way they lead a mutually supported life.

The present study was conducted in the Sumari village of District Pauri Garhwal in Uttaranchal. The village is located at a height of about 1370 mts. above sea level. It is situated by the roadside at a distance of about 2 – 2.5 kms. approximately from Srinagar, Garhwal. The village is accessible by road and is not difficult to reach. It has a total population of about 572 people. Total number of literate person is 338 out of which number of males is 219, while females stand at 199. The literacy rate in the village is about 75%. The village comes under Block Khirsu and the Patti Kattuulsiu. It comes under the collectorate of Srinagar. It is considerably a prosperous village with a rich cultural background. It has the honour of having the first district collector of the region during British times. It has a post office as well as an SBI branch. The village has primary school and an inter college for girls.

The present study was carried out in this village with a belief that every culture generates something equivalent to science, which works satisfactorily in its context. Effort is being made to explore that culturally specific understanding of the scientific and mathematical concepts among the Garhwali villagers. In most of the Garhwal villages the people work in the fields, construct houses, make tools and do many other household works themselves. In some cases they have specialists or elders who guide them, but otherwise they themselves carry out most of the activities. Their understanding of various physico-mathematical concepts embedded in these activities grows in the process of carrying out these works. Hence, all those people who participated in these socio-cultural activities formed the sample for this study.

DESIGN OF THE STUDY

The present study is an ethnographic field research. This is an ex- post facto scientific enquiry that aimed at discovering the relations and interactions among socio-historical, psychological and education variables in real social setting and their role in co-construction of peoples' knowledge of science and mathematics.

The present study is a "BlitzKrieg" ethnographic study which was conducted on a bounded group of people in Pauri Garhwal. In this type of research, the researcher relies upon several days of intensive fieldwork, rather than spending extensive time in the field. It cannot be called ethnographic per se, but rather a utilization of ethnographic methods and techniques for the purpose of data collection. The researcher did not have any control over the events and the research is done in a natural setting. The notes on observations and interactions are the major data source. The focus was to study how the individuals make meaning of events and actions and develop national understanding of mathematical and scientific concepts. In order to produce a strong ethnographic account, the researcher had to establish the trust of the group under study and tried to extract data from multiple sources in the field.

DATA COLLECTION

Since this study was an ethnographic field research, the attempt was made to explore the Garhwal culture in Uttaranchal. For the purpose of data collection, non-participant observation technique was employed. This type of technique refers to the situation when the observer/ researcher observes as a detached person without any attempt on his part to experience through participation what others feel. The choice for non-participation observation method in this study was not contingent on the observer's choice of sharing or not sharing the life of the group he is observing. Rather the constraint of availability of funds, time factor compelled the researcher to take such a decision.

The non-participant observation technique that was employed as a data collection method in this study comprises of extensive discussion and interviews with the people involved in the various sample activities for a period of one month. Audio recording was done of the detailed interviews of the villagers. This was supplemented with the photographs of the concerned data and informants as well. The information gathered in the field from the sample population was of utmost importance as it allowed the researcher to capture the perspectives and interpretations of participants. In a way it also facilitates the generation of genuinely novel insights and new understandings.

PILOT STUDY

A pilot study was conducted in the month of October in order to identify the village, sample the activities that would be studied and also to develop a checklist of questions, which was used by the researcher in final collection of data from the villagers. The checklists were not formal questionnaires but only a list of questions, which provided the researcher a direction to carryout observation and in-depth interviews. This pilot study also helped the researcher in establishing a rapport with the villagers and convince them that the researcher may not harm them in any way. The results found were satisfactory and provided necessary information. After obtaining the preliminary information on the region, village, the people and their activities, it was decided to go for a detailed investigation of the everyday cultural activities so that the villagers level of notional understanding of the scientific and mathematical concepts embedded in these activities could be documented and analyzed. The pilot survey unfolded certain other contextual aspects of the village life that helped the researcher revise the checklist of questions to be administered so that more useful information could be attained.

DATA ANALYSIS

Analysis of data refers to the computation of certain measures along with searching for patterns of relationship that exist among data groups. In the present study, content analysis of the data was carried out examining the contingent relationships between different cultural practices. A qualitative research is concerned with meaning in context and involves the interpretation of data. First of all, the interviewer transcribed the audio-recordings of the interviews with the informants. After the interview session was over, the transcription work was undertaken. Transcription is the verbatim description of the interviews or the narratives provided by the informants. The transcripts are then analyzed extensively so as to categorize the data under various thematic categories. The data were then categorized and each thematic category was their analyzed to reflect adequately on how and what kind of notional understanding people have of various scientific and mathematical concepts. Because of its very nature, the present research provided an opportunity to reflect on meanings and as a result, the study tended to be explanatory and holistic rather than a reductionist and a predictive work.

TOOLS FOR THE STUDY

A checklist of the broad area to be covered during the study was developed and used for the data collection. It was not a formal questionnaire but a list of questions to guide the researcher during the interview schedule. It consisted of questions related to the sample activities like house construction, agricultural practices, tools used etc. The checklist was originally prepared in Hindi but was translated in Hindi or the local dialect during the course of administration.

CHECKLISTS FOR SAMPLE ACTIVITIES

HOUSE CONSTRUCTION:

Before they start constructing a house, how do they decide the following areas of concern –

- . Choice of location, namely, what according to them is the ideal location for house construction. How do they decide on what side of the mountain should they construct the house? Why?
- . Choice of house design?
- . How do they decide the direction of the house that whether it should be east facing or west facing and so on?
- . What according to them is the ideal form of house in terms of proper sunlight, air, direction etc.?
- . How do they decide the number of doors and windows in their house?
- . What is the role of women in all these decisions?
- . What are the various ecological factors that shape these decisions?
- . What are the considerations in deciding whether to make a singly storied or a double storied house?
- . How do they decide the size of the house, numbers of rooms etc.? Is there any relationship of the number of rooms with a family size etc? After marriage do the children stay with parents? In case if there is a spilt, then how does the division takes place?
- . How and in what process the design of a house is worked out? Who is involved in the process? Do they do it within the family or somebody from outside the family is consulted?
- . When they actually construct a house how do they decide the length, breadth, height, angle etc. and

also how do they measure it?

- . How do they take care of the landslide related problems?
- . How do they decide the depth of the foundation of the house? Is it a consideration for the choice of land, like, whether they prefer a rocky land piece or any other type? What type of foundation do they make (namely, whether it supports all the four walls or only pillars are dug to form the base of the support system?)?
- . Do they have a single roof for the entire house? Or do they have separate roofs for each room? If yes, why?
- . How do they decide the slope of the roof? What are the ecological factors that form a base for this decision?
- . How do they balance the distribution of force of the roof on the walls? How do they make the choice of construction material? Do they have any consideration for keeping heavier weight downwards and making it lighter as they move upwards? What are the reasons behind it?
- . In house construction, who are an expert and a novice? How does the expert communicate with the novice and others? What is the role of women and children in the house construction process?
- . How do they decide the location of pillars in the house so as to have a balanced distribution of weight?
- . How has occurrence of earthquakes affected their conception of house construction practices? How has modern construction style influenced their house construction practices?
- . For example, say the size of the room is increased, how will they divide the force? (Whether they use beams or divide it angularly etc.)

AGRICULTURAL PRACTICES:

- . What are the different types of land found? How are these different? How do they make the choice of land for farming? (Factors such as location, sunlight, rocky area etc)
- . What type of farms do they have? Do they have big, spacious fields or any other type? What are the ecological factors behind such choice of land?
- . How do they measure the land for various purposes like division of land, sale, and purchase? What is the unit of measurement and do they have any specific symbol for it?
- . How do they measure the amount of seeds required to be sown in a piece of land for a good harvest?
- . How do they protect their crops against certain diseases? Are traditional methods employed or they use the modern pesticides? How do they decide the amount of pesticide required for a particular

size of the land?

- . Who are involved in farming? What role do women play in it? Are children also a part of the agricultural activities? What do they do?

TOOL MAKING:

- . What are the various agricultural tools used in farming?
- . Are the tools universal in the entire village or do they differ? How are they different?
- . Do they use specific wood or material for making the agricultural tools? What are the ecological reasons behind it?
- . While making the tool, how do they decide the shape, size, height, breadth, angle etc of the tool? How do they measure them?
- . Who makes these tools? Are they trained people belonging to a specific caste or professional group or, people in general make tools for themselves?
- . How do they develop the understanding for both making and using the various tools? Who trains them and How?
- . Are children a part of the tool making process? What role do they play?
- . Has modern technological development helped them in anyway? Which method do they commonly use and Why?

CHAPTER 4-DATA ANALYSIS AND DISCUSSION

Each culture creates its own folk knowledge, which is constructed and expressed in the narratives. An effort is being made in this study to explore the implicit scientific and mathematical concepts in the everyday activities of the garhwali villagers in order to see in them a reflection of local knowledge and folk wisdom which is developed by natives of the community in their attempt to adapt to the surroundings. The relationship between everyday practices and eco-cultural factors appeared time and again in the narrations provided by the villagers in this study. In this chapter a detailed analysis and discussion of data has been done by the researcher under different themes which goes as follows:

1.1 SCIENTIFIC CONCEPTS EMBEDDED IN THE TRADITIONAL HOUSE CONSTRUCTION PRACTICES IN VILLAGES IN GARHWAL REGION

The average height of the houses in this village was found to be in the range of 4.5-5.5 ft. One villager, Mr. Chamoli told us that in a typical '*Pahaari*' house, height is kept low because of various reasons. His reply is quoted in the form of his narration as follows:

“ See the houses in the region are of low height. Firstly, because the roof is made of stone slabs or 'Pathals' which are very heavy and difficult to carry. 'Pathals' are stone slabs that are extracted from the mines or 'Khaans' located high up in the hills. These are very heavy pieces.....so, in case the walls are too high, then, it would be difficult to balance the structure. By keeping the height of the room low, it was easier to carry them, stack them and also balance them.....”

We asked another villager, Mr. Kala, why do they have such small sized doors and windows in their houses? He replied that primarily because of the extreme cold conditions in the region, they have such an arrangement. It would be very difficult for them to keep themselves warm and cozy in case they had really big doors and windows. He told that during rains, wind blows from the east. Thus, generally, all the houses in the village keep their entrance or main door in the opposite direction. The number of doors and windows is also kept at minimum so as to avoid the problem of water seepage inside

the house.

The same question was put to Savitri Devi, an 85 year old woman from the village that why doors and windows are small in size in her house. She laughed and replied that she has been seeing them since her marriage. Her daughter-in-law, Kamla Devi, who was standing nearby, intervened and said that as it is very cold in the region, this arrangement helps in protecting oneself from extreme cold. The old lady however provided another social reason for such a scientific decision regarding house entrance. She replied in the form of a narrative, which runs as follows:

“.....Beta it is so believed that 'Ganeshji' resides in the 'Chaukhat' or entrance of the house. In order to pay reverence to the Almighty, one should bow down his or her head..... Lowering the height of the doors compels everybody to bow down his or her head at the entrance of the house.”

Another villager, Mr. Ramesh Chandra, a 42-year-old farmer by profession, was also questioned on certain topics. He told that the reason for keeping the height of the house low is the extreme cold conditions prevailing in the region. An old villager, Bhagwati Prasad Rodola an 82-year-old man, added on the information regarding this area. The narration given by him is as under:

“..... that in hilly areas, people are not very tall. Due to the climatic conditions, human beings as well as animals both have a restricted growth. So the height of the house is kept low because it would not be a very wise decision to make tall houses for people with low height.”

We saw Mr. Ramesh Chandra's house and then enquired about certain areas of interest. We asked him that while constructing houses how do they measure if the two walls of the house are equal in size or not? He told that in earlier times people used to depend on the mason entirely for their house construction. They believed that the mason has the God's gift through which he could make accurate walls and structures.

When the same question was posed to Mr. Moyal, a mason by profession, he replied that they used 'Suut' or thread string to measure the accuracy while constructing a house. He replied in the form of a narration, which is as follows:

“.....See the villagers and also we, the masons, believe that we have the ability to accurately perceive a straight line or wall. Not everybody in the village can do

it as accurately as we do. For the purpose we use 'Suut', by measuring the diagonal distance between the two walls..... and thus find out whether walls are equal or not."

Thus according to the aforesaid narration the masons measure the diagonal distance between the two walls with the help of a string. If distance between both the walls is equal, that means, the walls are coming out straight. 'Suut' was the most easily available and commonly used means to measure the accuracy of any line.

The researcher then asked to kindly explain how do they measure the accuracy of the angle while constructing a house? His reply is given below in the form of his narration:

".....While constructing a house we make of an instrument called 'guundiya' which is made of wood or iron. In old days masons use to make it themselves by taking a round piece of wood and then dividing it into four equal pieces from the center.....now nobody makes it and buys from the local market."

Another mason by the name Ramesh who was standing nearby came up with his version of how to make a guundiya. His views are given below in the form of his narration:

".....for this we take a round piece of wood and divide it from the center..... and from that line we put two 'koand' or arcs on the border of the wood piece.....we then draw a line from that point to the ends of the wood piece which makes it equal to a 90degree angle....by cutting across the wood piece from these points we can make a guundiya."

The average length of a 'Pahaari' house ranges between 10-12 ft. Various reasons are responsible for such a decision. We asked one villager, Mr. Kala about the house construction pattern in the region. He readily agreed to fulfill our desire to see his house. His house was a sixty years old, two-storied building. The ground floor of the house was meant for keeping the cattle while the family members resided in the upper storey. The outside view of the house gave an impression that it was more like one big hall having three small windows at regular intervals. When we went inside to have a look at the house, we found some three rooms inside it. He told us that the houses in this region have

one common roof which is further divided into a number of rooms as per the owner's choice, with the helps of the walls drawn from inside. He told that house construction in the hills is a long time affair as it sometimes takes several months or even a year to make one house. As these houses have a common roof hence they do not make very big houses. The average length of a 'Pahaari' house is 10 ft. by 12 ft. or 5-7 *Haath*. (1 Hand is equal to 18 inches approximately in local terms). The narrative provided by him supports this idea:

"Beta, look my house is of 10 by 10 ft. but here in our village you can find houses up to 12 ft. long as well. It is not conducive to built very long rooms in this region primarily because of the building material used to make the roof..... It is very heavy and so it would be difficult to balance them in very long houses. Even though now circumstantially I have shifted to a tin sheet roof but still the framework of the house is the same small one which could support a 'Pathal' roof best....."

He provided one more reason to support their idea of having not so big houses. Wooden planks or beams have to be used in the roof and it is to be kept in mind that they have an approximate natural length. As the *dwar*s or beams of the roof are supposed to be without any joints, hence keeping this in mind people try to keep the length of their houses somewhere near this limit. The villagers in Garhwal do not make any pillars inside their rooms to support the roof. The entire force of their roof rests on all the four walls of the house. While constructing a house, they start from the foundation, which is generally 2.5-3 ft. deep. While digging the ground, if they get '*Pakki Zameen*' then they may stop beforehand. '*Pakki Zameen*' refers to the point where one hits big stones under the ground. Once the foundation is laid, the walls are built with the help of big stones and small pebbles to fill in the gaps. The walls in the village houses in Garhwal are really broad ones. In earlier times, people used to have even 22-24 inches or 2 feet broad walls. One villager, Mr. Ramesh Chandra, in his narrative told us about this aspect:

"It old times, people used to have very broad walls in their houses. See in my own house! It is about 150 years old and still standing tall and strong. The walls in my house are 24 inches or 2 feet in breadth..... In old days, people wanted to make the house very strong and for them, more is the breadth, stronger is the house. But, now you see, people do not have that much of patience to continue building

one house for months. So see those comparatively newer houses have walls ranging between 16-18 inches in breadth....."

In the wall making process, the scientific idea underlines the local practice prevalent in the garhwali villages. The walls are built with the help of big boulders and small stones. The stones are so put that no gap or crevice is left between the big boulders. The bigger stones are used at the lower end with the one's smaller in size in the upper parts. This idea of having a well packed broad wall helps at the time of climatic mishaps like earthquake, strong winds etc. The broad wall sways as a single unit and this prevents it from falling and breaking. Mr. Ramesh Chandra, a villager showed us a house near his own house, which had a crack in its wall. His narration in this context goes as follows:

"Look I told you that packing of stones is an extremely important step in house construction. Care is to be taken in carefully packing the gaps between them so that they come out as one single unit. In this house opposite to mine, probably they did not take care in making the wall..... If stones are not packed well, then during an earthquake they will rub against each other and the wall will break very easily....."

If we judge his statement scientifically, then in terms of physics also friction between two components of a thing should be minimal to avoid wear and tear. Here in this case, one of the villagers Mr. Harshpati Juyal told us about the reason behind making a well packed stonewall. His reply is as follows:

".....all of us (the villagers) have an idea that while making the wall of the house extreme care should be taken to minimize the gaps between two stone pieces so that they stay at their places.....In case if the wall is not well packed then there would be more gap between the two stones and they would not be able to face the external pressure of earthquake or strong winds effectively.....Any such type of external pressure would make the stones move and due to the gaps in between they would hit each other thus making the wall liable to break down easily."

The aforesaid narration justifies the idea of the villagers of accurately putting small stones in the gaps thus filling all the crevices and coming out with a dwelling structure that behaves as a single unit.

1.2 RELATIONSHIP BETWEEN CHOICE OF CONSTRUCTION MATERIAL, ECOLOGICAL CONDITIONS AND MAINTENANCE OF ROOM TEMPERATURE

The prevailing ecological conditions in the region force the villagers to keep the height of their houses at low level. As the village is in extreme cold region of the state, it may be judicious to make low roofed houses, so that the houses are kept more warm and cozy in winters. Evidence comes from the narration given by a villager, Mr. Kala:

"Less number of doors and windows are found in the houses in the hills because more is the number, more difficult it is to maintain warmth inside the house in extreme cold conditions. The Pathals also help in maintaining the room temperature.....Houses made from these remain cool in summers and warm in winters..... I am forced to shift to tin sheet roof because of otherwise who would like to move away from a system which proved efficient in the given eco- cultural conditions....."

This idea of using *Pathals* get backing from the scientific view that stone is a good conductor of heat. This quality helps it in maintaining the optimum temperature inside the rooms. Scientifically, there are three ways of heat transmission. In one of them, that is, conduction, heat enters one end of the body and is transmitted along its whole length. This process of heat transfer takes place mainly in solids. Substances such as wood, cotton, wool and glass are bad conductors (good insulators) of heat. For example, Eskimos live in houses made of snow called igloos. Snow, being a poor conductor of heat does not allow the heat generated by the human beings from escaping the igloos and thus protect them from cold.

Likewise the villagers in this village explained the importance of 'Pathals' or stone slabs in the traditional houses in Garhwal. The researcher asked a villager Mr. Rajendra Prasad Kala to kindly tell the reason because of which they use pathals as a house construction material. He gave a detailed narration as his reply, which is quoted as under:

" The stone slabs or the Pathals, as we call them in the region, are extracted from the mines situated high up in the hills. From a big rock, numerous pathals can be

extracted..... The rock, naturally, has various layers depicted by very minute lines. By striking at those lines with a chisel and hammer, the villagers are easily able to separate the slabs from the rock. These stones are then carried to the construction site which are then used by the villagers to make the roof of their houses.....”

When we talked to the villagers, nearly all of them mentioned that how good are *pathal* roofs for the houses in all seasons. One villager Mr. Dinesh Chandra Rodola 45 years old had a house made of these *Pathals*. We asked him that why according to him the *pathal* houses are better for the region. He said that:

“.....look Beta, stones are so strong and thick that they do not allow anything to pass through it. As the Pathals are extracted from big strong mountains..... hence even they have this quality. Our ancestors have been living in such houses from time immemorial and it has been found conducive to this climate..... So even we have adopted it.”

If analyzed scientifically, this idea of the illiterate villagers has a sound scientific basis even though they may be using local unscientific language. Bricks are porous and therefore continuous rainfall in this region would cause acute dampness in the house, thus making it unfit to stay. Damp houses are usually cold, making the conditions worse in extreme winters. *Pathals* are stone slabs, which is a non-porous material. It doesn't allow water to seep through them. As this region experiences continuous and heavy rainfall, use of *pathals* helps a lot in keeping the house safe and comfortable. The most important point in a *pathal* roof is accurate lying of the *Pathals*. The manner in which the villagers arrange them is worth noticing. The pattern of laying a *pathal* roof was explicitly explained to the researcher by a villager Mr. Harshpati Juyal. His reply is quoted as follows:

“.....here in the village or rather the whole of ‘pahaar’ we people always construct the roof from sideways and then go towards the centre. In this practice, each underlying pathal is covered by the one acceding it and so on..... The crevices between the two pathals are thus covered and this helps in preventing any seepage of rainwater inside the house..... When the center is reached then we seal it nicely with the help of small stones and mud so that it is nicely packed. This is the

point where the force of the entire roof lies and it is very important for roof construction. It is known as the 'Dhurpula Dwar'. In case the roof is to be repaired, then we start unwinding it from the central part that is, the Dhurpula Dwar."

A narrative provided by another villager, Mr. Ramesh Chandra, justifies the scientific systematic idea embedded in this action:

"Whenever we make the roof of the house, we start putting the pathals from sideward towards the center. See in this manner, the pathals at the upper side presses the one beneath it, thus making it more stable..... Also because of this practice the water flows down completely without getting into any openings. The Dhurpula which is the lifeline of the roof provides stability and makes the roof more strong....."

The *pathals* also help in maintaining the right temperature inside the rooms because of its specific qualities. It is a scientifically proven view that stone is a good conductor of heat. It receives heat from the sun by conduction and in turn becomes hot, thus keeping the house warm and cozy in extreme cold conditions. Wood, on the other hand, is a bad conductor of heat. Bad conductors are good insulators. Keeping this property in mind, wood used in the roof does not allow the heat generated by the human body and other means to leave the room, thus maintaining the optional room temperature. These villagers know these properties of the pathals and wooden beams even though their understanding of these concepts may not be all that scientific. The scientific and mathematical ideas are found to be embedded in the traditional everyday practices of the garhwali villagers, which help people to withstand the extreme climatic conditions that prevail in the region. Hilly areas in Garhwal region mostly face the problem of cold conditions and to safeguard against such problems *pathal* houses are very effective. However in summers also it helps it keeping the house cool. It is so because being a good conductor of heat, stone does not have good insulating qualities. Hence it conveys heat inside the room away quickly. Besides this, what so ever heat it conducts from the sun is prevented from entering the house fully by the wooden beams used. Wood being a bad conductor of heat conducts heat from the touched surface only. Hence only a small amount of heat is conducted inside the room. Whatsoever small amount of heat the roof conducts is again conveyed away by the stone used in making the walls of the house.

Hence the choice of the construction material by the villagers proves their inner, local wisdom, which they must have acquired through their constant interactions with their environment and the available resources.

1.3 DISTRIBUTION OF PRESSURE IN THE TRADITIONAL HOUSE PATTERN IN GARHWAL

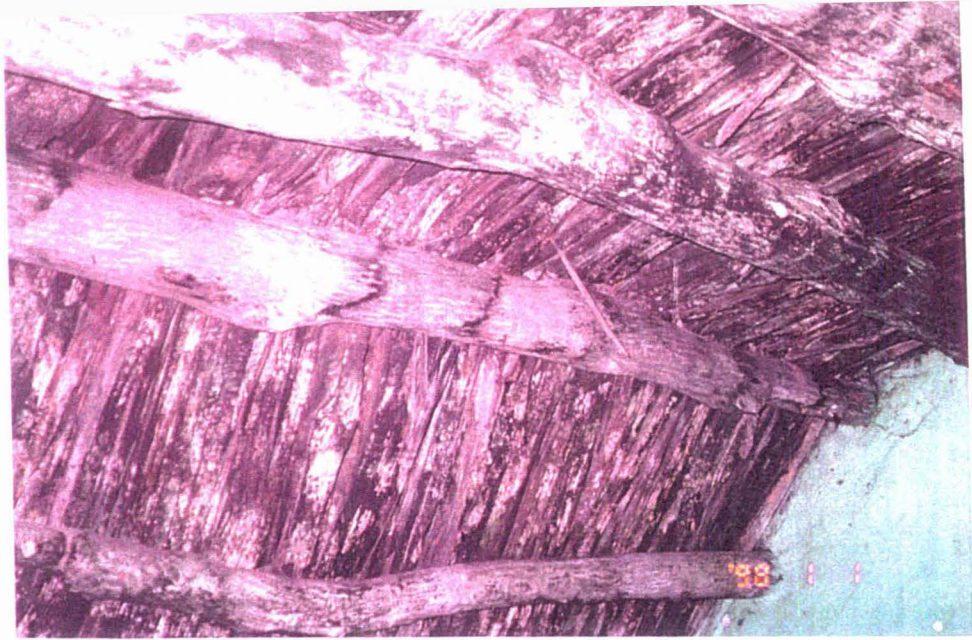
House design varies in Uttarakhand due to the diverse topography of the region. The angle of the slope, number of storeys etc. are decided on the basis of the different background factors.



PICTURE SHOWING THE TRADITIONAL TIBAARI IN A HOUSE IN GARHWAL

This practice of using extended support helps in converting the entire vertical force on the wall and makes it horizontal. One villager Mr. Rajendra Prasad Kala told about the importance of putting extended supports in a house. His reply is as follows:

“..... As the Sahwan is made of wood pieces, which are half buried inside the wall, hence they are strong enough to bear the pressure from the roof. Also these Sahwan support the pathals to stay on in their places..... While constructing the roof, the stone slabs are not plastered or bound by any other means. They are just placed accurately at the right place and allowed to stand there. Being very heavy they do not get displaced very easily and can withstand normal weather conditions



PICTURES OF A TRADITIONAL GARHWALI HOUSE



for up to 2 years Sahwan extend an additional support to the sloped roof and hence prevents the Pathals from falling by chance.

By putting these *Sahwan* between the roof end and the vertical wall, the villagers have shown their local wisdom and hence prevented the entire vertical force of the roof from falling on the wall. Otherwise, there would have been a lot of pressure on the walls thereby making the structure weak and liable to break easily.

When the construction of the walls is complete, then only the wall at the two ends breadth wise and not the other two lengthwise sidewalls, are built up to a point till which people want to keep the height of the roof. While constructing it, they also keep on placing the *dwars* or horizontal beams simultaneously, to form a base for the laying of the roof. One point to be noticed here is that the villagers do not put the entire pressure of the roof on the sidewalls on which the roof rests. The *dwars* are put horizontally across the other two walls. In this way, they are able to distribute the load of the entire roof on all the four walls of the house. In this way the four walls of the house uniformly share the weight of the heavy roof.

Similarly in modern science, pressure is defined as force acting per unit area. For example, broad wooden sleepers are placed below the rails to reduce the pressure exerted by the weight of a train. The pressure exerted by the train running on tracks is great enough to press the tracks into the ground thus deforming it. The placing of the broad wooden sleepers distributes the entire vertical pressure, thus converting it into horizontal pressure. In this way there is no overload on the rail tracks and they are able to maintain their correct form.

While observing the different features of a traditional village house belonging to Mr. Ramesh Chandra, we asked him that what were those extensions seen regular intervals beneath the '*Tibaari*' or the living room in his house. To this he replied:

"These are supports to balance the heavy roof on top. We do not put pillars to distribute the roof load to other sources..... In case if the entire load is allowed to stand without any support then there are chances that it might fall. Therefore for a stone slab we make extensions out of stone by shaping them and putting them inside the wall in a manner so that it covers the entire thickness of the wall. The other half of the stone slab which is outside acts as a support to the balcony / chajja (niimdaari-local

term)..... ”.

Here, the vertical force of the balcony is shared by the stone supports, which convert it into a horizontal force, thus making the *niimdaari* more strong and stable. The exact local term for these stone extensions was provided by one of our important informants, Mr. Harshapati Juyal. He told us that these were called as 'Satir' and they supported the local belief that more broad an object, more strong it is. That is why breadth of a 'Satir' is double that of the wall in these houses because half of it is buried inside the wall and the other half stays outside.

All the houses, which we visited during our study, showed that these villagers in order to share the large amount of force or the load did not use any separate pillars in the roof construction process. However it was found that some beams roughly run across the room diagonally. When we asked the villagers about its utility, they could not give a very explanatory answer for this. Some said it could be used to store things and so on. There were others who explained it to be providing extra support to the roof.

The researcher after talking at length to a number of villagers came to the conclusion that the cross-sectional beams running across the room in these village houses not only help in converting the large amount of vertical force into horizontal one but also distribute it uniformly among all the four walls so that the entire force also not fall on a single object. This provides more stability, strength and life to the house. This is evident from the fact that many houses in the region were able to withstand the massive earthquakes from time to time. The distribution of force in the house construction style is therefore very important so as to make these structures more and more effective in dealing with the environmental hazards.

2. TRADITIONAL AGRICULTURAL ACTIVITIES AND TOOLS USED IN A VILLAGE IN GARHWAL

The traditional agricultural system that prevailed in the hills was a self-reliant one. The villagers themselves with the help of the locally available wood and other metals made ploughs and other necessary tools. Traditional crops of *Mandua* and *Jhangora* helped people in having enough food grain for their consumption and plenty of

fodder for their cattle. The local traditional knowledge of the biodiversity allowed them to make use of the available wide varieties as manure and food. Thus, with an intention to explore these activities a visit was made to the Sumari village of District Pauri Garhwal in Uttarakhand. All those people who were engaged in agriculture in any way were interviewed. The purpose was to elicit the folk wisdom used for measuring different units while doing day-to-day activities in the village life. First of all, we visited the house of one villager Ramesh Chandra (42 years) who was a farmer by profession. He had a good house which was some 100 yrs old and in a good condition. After having a general conversation, we asked him what was the farming style in their village? To this his reply is given below as a narrative:

“.....here in hills, we have a popular practice of 'Baara-anaaj'..... During rainy season, people put some twelve different varieties of seeds in their fields. This practice helps us a lot to have ample amount of food-grains for the winter season..... and also our lands do not lay vacant.”

We then carried the discussion forward and asked him to tell in detail about the process of farming. His narration is as under:

“Before sowing seeds, we- the farmers draw a line in the straight direction alongside the plough. This is known as 'Aal' or 'Syul'. Its purpose is to help the farmer in sowing the seeds in one straight line..... Otherwise, it may happen that the farmer may forget and sow seeds twice in once place and leave the other patch empty.....”

'Aal' helps the farmer in keeping track of the position to sow seeds and thus avoid the wastage of the seeds sown. After this information we asked him that how does he measure his land in the village? He replied that traditionally, in the village, there are two units for this purpose namely, 'Naali' and 'Baath'. There is no fixed amount of seed that is to be put in a piece of land. But approximately in 1 'Naali' of land some 16 *mutthi* (a handful) of seeds could be spread. This was the villagers' own indigenous method for the measurement of land. We, then, curiously asked about what would be the measurement for 1 *Baath* of land. This was much more interesting than the first one. He told that whatever amount of land that can be ploughed in a day would be equal to 1 *Baath* of land. Surprised with this idea, the researcher said that in a day people can

plough a long stretch of land, then how will they decide how much is 1 Baath. He laughed heartily and replied as follows:

“.....In village life one day is equal to the period from morning 7 or 8 o'clock to 12 o'clock in the afternoon- approximately 5 hours. Usually people work for only this long in the fields in the garhwal region. Beyond this people avoid because of the reason that the sun is overhead and then it is very difficult to work..... Hence these five hours roughly make a day for the village farmers and whatever land is ploughed during this time is equal to 1Baath of land.”

We then curiously asked him about the relation between *naali* and *baath*. He told that,

“Some 2.5-3 naali of land together makes 1baath of land..... When we sow the seeds, the amount of seed put in a piece of land would also depend on the type and size of seed. For example if the seed is big in size, like wheat, then 1 Paantha of seed would be used. But, if it is some smaller grain like Mandua then, only a quarter of the earlier one (i.e. wheat) or 1 Maana seed would be needed.....”

We asked him the reason behind these decisions. He replied that that it is so because a seed big in size would be less in number and hence while spreading it may fall short in quantity. Whereas, grains small in size spread easily as it is also more in number even though it may weigh the same as the grain bigger in size. Thus the amount of seed to be spread in a piece of land also depends on its own size.

After this detailed talk with him we then moved to the house of another villager, Rajendra Prasad Kala, who was sitting and chatting with a group of people in front of his house. We asked him for his permission to spare some time for us so that we may talk about their village as well as about their own lifestyle. He along with the others readily agreed and said it was a rich tradition in his village to respect and take care of the guests in every possible manner. We started by asking him about the local unit used for the measurement of land? He said that there were two units used by the villagers, namely *naali* and *baath*. Amongst these *Naali* was a more popular term. Then we asked him to explain how much land is included in 1 *Naali*. To this he replied in the form of a narrative, which is given as under:

"In village life there is no exact method for the measurement purpose but we (all villagers) have a rough idea that it is equal to some 16 mutthi of grains....."

Meaning to say, that in whatever stretch of land this much amount could be easily spread was measured to be equal to 1 *naali*. A continuation of his narration in this context is as follows.

"Arre beta, in village we people do not bother to do the exact measurements. All of us have lands so no one bothers to put one exact mark on it. Some amount of difference does not matter to anyone of us. After all, it is going to some other brother only..... So we take 16 mutthi seeds and sprinkle it on a piece of land to calculate one naali....."

He further told that first of all the farmer divides his piece of land into four pieces according to his own idea. He then starts sprinkling seeds in one piece, thus measuring land in *Naali* and then gradually moves to the larger unit, that is, *Baath*. We then asked him that how much land is equal to one *baath*? To this he replied in the form of a narration, which is as follows:

"..... 1 Baath of land is equal to 2.5 naali approximately. So after measuring the land in naali, one can convert it into a larger unit that is Baath. The ladies in the house give the seeds from the house granary to be sown in the fields for which they have their own measurement."

We requested him to kindly elaborate on this idea. He politely expressed his incapability in doing so but suggested that on the upper end of the village there is the house of an old lady, Savitri Devi who can perhaps help us.

Next day, we headed for the house of Savitri Devi and asked her about how does she measure her fields? She replied in a narrative form, which is stated below:

".....the men of the house did this job, as they were the ones who plough the land. But as we women sow the seeds, we use our own decisions regarding the amount of seed needed for a piece of land..... for 1 baath land we used to give 6 Maana seeds to be sown. As 1 Baath is equal to some 3 naali, so for one naali, we used to sprinkle one-third of this total amount, that is, 2 Maana seeds."

Now we have been introduced to a new measuring concept used by the women in the village that is, Maana. We asked Savitri Devi to kindly elaborate on the concept? Her narration goes as follows:

"In all the houses in the village, two units of measurement are used and these are known as Maana and Paantha. They are used to measure almost anything in our day-to-day chores. In the time of marriage or festival, whenever we have to prepare and give any commodity in large quantity, we measure using these units only....."

Maana and *Paantha* are two containers used for measurement purpose in the traditional Garhwali community.



PICTURE OF THE TRADITIONAL MEASURING UNITS-MAANA AND PAANTHA

Maana is a smaller unit, which as told by Savitri Devi is equal to 1/2 kg. It is made up of wood or copper metal. In village they use the term *Ser* for half a kg. So going by these standards, 1 *Maana /Maani* is equal to half kg or half '*ser*'. She told us that *maana* is a very small unit and is used for measuring food grains for cooking at home.

Paantha is considerably a bigger unit and is shaped as a 'U' shaped tumbler made of wood or copper metal. According to Savitri Devi, it is equal to 2 kgs. approximately or 4 *Maanas*. Since it is a bigger unit, it is used more often in barter system for measuring food grains.

After getting this detailed introduction to these two units, we went back to the point at which our discussion proceeded to a new direction. She had then said that for one *baath* land she used to give around 6 *maana* seeds, which are equal to 3 kg. So now we can say that for 1 *naali* of land, the Garhwali villagers put some 2 *maana* or 1 kg. seeds approximately for a good harvest. The women at home used this measurement style.

Suddenly, Savitri Devi introduced us to a new idea of measuring land. She said that for their convenience people had one more level of understanding. Different people can sprinkle more or less amount than 16 *mutthi* of seeds. But in order to keep the variation level low, the villagers developed an idea that four seeds approximately should be sprinkled in the area equal to the foot of an ox. I asked her that how was it possible for the farmer to measure so small amount every time accurately. Her reply in the form of her narration is as follows-

"This is not an exact measurement but only an approximation..... It only saves us from putting too much or too less amount of seeds in one particular area. It also helps in the equal distribution of seeds and hence assessing the exact measurement of the land area....."

After this, we asked her how land was divided amongst the brothers in a family? She said that after the death of parents if a distribution of property is to occur then it is held amongst the brothers on mutual grounds or sometimes with the help of the family friends. Under this system, as a local practice, the elder brother gets an extra piece of land and also the east-facing portion of the house. We asked her the reason for such a setting. Her reply to this is as follows:

".....For no specific reason this has been a traditionally followed practice in the entire village..... As a token of his being the elder and for taking the responsibility of the family upon him, the eldest brother is given the first choice, that is, east facing side of the house. He is free to choose the land piece of his choice."

Another curiosity cropped up and we asked her that what happens in case the younger brothers do not agree to such an arrangement. Seemingly my question was too immature for her. She again smiled and said:

"You city people are only up to the exact, equal distribution of any commodity. But in village life it is not so. All of us believe in the mutual decisions taken by all the family members but, in case, there is a problem, then, they have to abide by the decision of village panchayat called for the purpose....."

After this we went to the house of another villager, Mr. Harshvardhan Chamoli, to enquire about this area. As he had given us some good information on house construction so we thought to enquire him on land measurement and agriculture as well. We asked him to kindly tell us something about '*Maana*' and '*Paantha*'. He told us that *maana* was a smaller unit of measurement equal to 1/2 *ser* as compared to '*Paantha*', which is equal to 4 *maana* or 2 kg. During the time of marriage and other such occasions, people used to give sweets to the girl's family in a unit called '*Duun*'. It is measured in terms of *Paantha* itself, as it does not have any specific weight or measure. 1 '*Duun*' is equal to 16 *Paantha* or 32 kg. They make '*Tokari*' which is a container shaped as a basket and made of locally available *Ringaal*, used for measuring and giving large quantities of a commodity.

One '*Tokari*' or Basket is equal to 4 '*Paantha*', that is equal to 8 kg. Similarly, 2 Baskets of 8 *Paanthas* will together be equal to 1 *Duun*, which is equal to 32 kgs. In this way, they use to develop a generalized form of their knowledge. It can be very clearly seen that the Garhwali villagers developed their measurement system on two basic units. These 2 units helped them in measuring very large to small quantities of goods in day-to-day life activities. The traditional agricultural system that prevailed in the hills was a self reliant one. The villagers themselves with the help of the locally available wood and other metals made ploughs and other necessary tools. Traditional crops of *Mandua* and *Jhangora* helped people in having enough food grain for their consumption and plenty of fodder for their cattle. The local traditional knowledge of the biodiversity allowed the villagers to make use of the available varieties as manure and cattle-feed.

The practice of '*Baara-anaaj*' made them self sufficient to fend for their needs. It provided them with enough resources through which they could survive even in extreme cold conditions. This practice reflects their folk wisdom about nutrients. It consisted of different varieties of food crops, which provided all necessary nutrients to the people in all the seasons. It has been found scientifically that *mandua* has high calcium content in it, which is responsible for strong bones in people. In the context of garhwal, people need

to have stronger bones as compared to the plains because they have to commute up and down the hills. In case they do not get this necessary supply then this will affect their performance level. When the researcher asked Savitri Devi to tell why does she think *they eat mandua*. She replied in a narrative form, which is as follows:

“..... People use mandua to make chapattis in their everyday fooding. It helps in keeping them warm during cold conditions due to its inherent quality.....Also we can use it as a substitute for wheat which is a finer grain and needs good care for cultivation.....owing to its coarse variety mandua grows easily in the hills without much care. Also it is easy to digest and allows us to be active in our daily works.”

Presently many international companies are planning to use it in making baby-food owing to its light nature, which makes it easily digestible even by the kids and also due to its nutritional value.

3. TRADITIONAL AGRICULTURAL TOOLS IN A VILLAGE IN GARHWAL

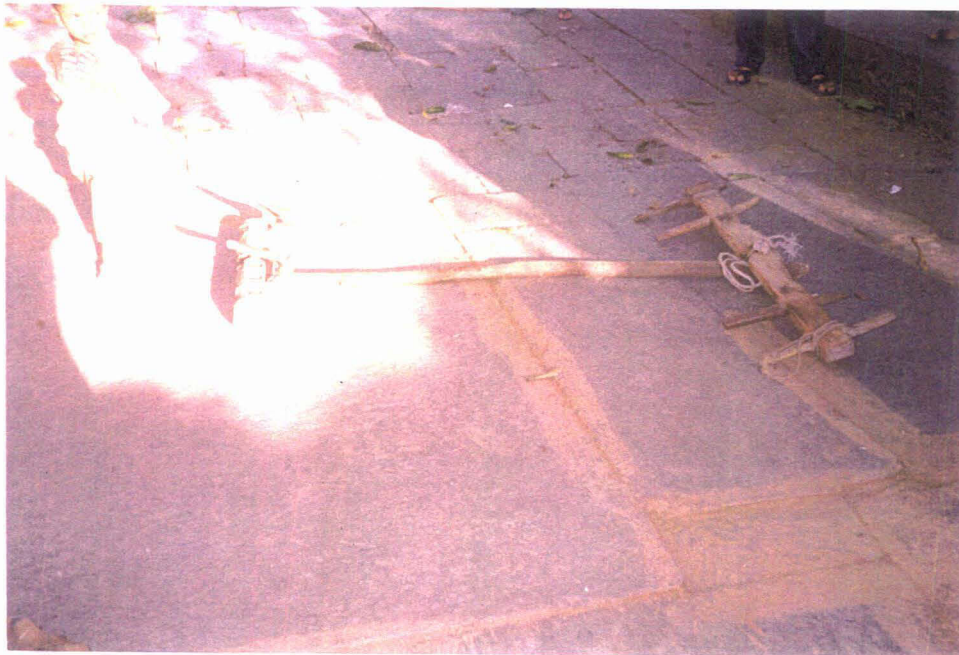
While doing agricultural activities, the villagers use different agricultural tools made by himself or herself or by the village carpenter. These tools are somewhat different from the universally available tools. It is because of their inherent qualities, which make them specific to their region. To probe this specificity, we visited the houses of a number of villagers in order to get some first hand information in this context. When we visited the house of a villager, named Rajendra prasad, he was sitting with his family members while the ladies of the house were busy drying the harvest for future use. We asked him to kindly show us the traditional plough and other such tools used by them in farming. He took us to the lower part of the house where the tools were kept, as it was the farming off-season. There, we saw a traditional plough used in garhwal villages and asked him to tell us about it in detail.



KUTLI

NISDAA

PICTURES SHOWING TRADITIONAL AGRICULTURAL TOOLS
USED IN GARHWAL



DANDLA

He told that in the region people do not make very big tools. The average height of the plough is somewhere between 3 1/2 to 4 feet. When we asked him the reason for keeping the height so low he said:

“In the region people as well as animals are not very tall or high so we prefer keeping the heights of our tools low so that people can use them convenientlyYou can see yourself that the bulls here are comparatively shorter than the ones found in the plains. This is an important point of consideration while designing the tools.....”

In our observation, we actually found that the bulls in the region were quite small in size. Probably, low height helped them in climbing up and coming down the steep hills easily. He further extended his narrative in this context, which runs as follows:

“..... suppose the bulls here were as tall and heavy built as the ones found in the low lying areas, then it would have restricted their free movement in the hills. Also it would have been more risky not only for themselves but also for the farmers as a heavy physique is difficult to balance in case of any emergency..... Therefore, for a small bullock, we will have small ploughs so as to make the tool more effective.”

In a traditional plough, the length of the long rod is kept between 8 to 8 1/2 feet approximately. This rod is called ‘Laat’ in the region. and it is very important to keep its length according to the specified norms so as to make it region specific. This distance is kept so much as to prevent the *Nisdaa* (lower part of the plough meant for digging) from touching the feet of the bullocks because otherwise this will affect the proper functioning of the plough. The villagers make use of the locally available wood of *baanj* tree for making the lowest part meant for digging the soil as *baanj* wood is very hard and does not break easily on hitting the stones under the soil. Also it is easily available to them in their own locality. He added that, now, as the government has imposed ban on the cutting of trees, we have been forced to use iron instead. It is not liked by us because we have to go to the ironsmith for any problem encounter. Whereas initially we could easily mend our tools with the help of another tool called ‘*Baansula*’ which was used to repair the plough by the farmer himself.

Then the researcher turned towards his neighbor Harshpati Juyal's house for gathering more data on agricultural practices in garhwal region. He said that other than the plough the villagers use a small tool called 'Kutli' which is used to dig those portions of the field where bullocks cannot reach. We requested him to tell something more about it. His narration is given as under:

“Here in the hills, the fields are not spacious ones. Rather they are made by cutting the steep slopes into terrace shaped farmlands thus making it feasible for farming..... Because of this there are some very sharp and narrow bends where bullocks cannot go. Such stretches of land are tilled by the women or children with the help of Kutli, a tool in the shape of small Faavda, to help the farmer in digging the entire field.....”

The manner in which the villagers in the region make their tools and carry out their agricultural activities makes one thing very explicit that they have an in-depth knowledge of their surroundings. They are well aware of the climatic and geological variations of their region as compared to the plain areas. Therefore they have developed their own understanding and knowledge of doing their everyday activities over a number of years, which guides them to tackle their environment successfully.

DISCUSSION

The aforesaid narrations were provided by the garhwali villagers in the Sumari village in Pauri Garhwal, as a response to the questions of the researcher. As per the observations of the researcher, the manner in which these villagers perform their everyday activities reflects a systematic and region oriented approach to carry out day-to-day activities. The scientific and logical reasoning may not be very explicit in these practices yet they form an integral part of the lives of the natives as they allow them to adapt efficiently to their surroundings. Findings of the present study reveal logical setting and implicit scientific and mathematics concepts embedded in the everyday practices of the garhwali community. These practices are based on the culturally transmitted

indigenous knowledge of the garhwali villagers, which aims at increasing the sustainability of the community.

The narrations provided by the villagers with regard to the house construction practices of the region reveal their in-depth understanding of the surrounding ecological conditions. One of the villagers Mr. Harshpati Juyal explained about what is their idea of force? As per his narration, the villagers thought of force in terms of load or *bhaar* (local term). Their main aim is to keep the *bhaar* of the roof on the walls of the house as less as possible. They use stone slabs or *pathals* in roof construction, which are very heavy in weight and this automatically, increases the roof load. Therefore the villagers use extended supports of wood or stone called '*satir*'. These supports help to convert vertical force of the roof into horizontal one, thus sparing the wall from bearing the entire load of the roof. In the entire conversation none of the villagers used the term 'force' and instead referred to it as *bhaar* or load. But this reason does not mean that their understanding of this concept is less than the others in any way. The manner in which they manage their life activities with a low and less varied resource base makes the entire process all the more commendable.

Mr. Muiyal who is a mason by profession in his narration told that while constructing houses in this region they use a string or thread to measure the diagonal distance between two walls. If distance between both the walls is equal, that means, they are coming out straight. '*Suut*', that is, the thread is the most easily available and commonly used means to measure the accuracy of any line. For this purpose they also used an instrument called '*guundiya*' which is made of wood or metal. It is an 'L' shaped instrument. These people do not talk in terms of angle but instead make use of the term '*koand*', which means the same thing.

The use of *pathals* or stone slabs by the villagers' in house construction process is another fine example of their folk wisdom. As per the villagers' narrations these *pathals* help in keeping their houses warm in winter and cool in summers. They could not explain the process logically yet their choice of it as a material signifies a lot about the rich base of their knowledge system.

The traditional agricultural system in garhwal embraces the most important feature of being holistic and comprises of all land related activities starting from

cropping, animal husbandry, forestry etc. These components are in organic linkages with each other. This traditional agricultural system is 'closed', self-contained and self-reliant. Mountain agriculture system assists the villagers in facing the brunt of the extreme climatic conditions and provides them the required nutrients in the form of wide variety of food grains cultivated in the region. The prevalent cropping pattern relies completely on the ecological conditions. The villagers follow a multiple crop system called as '*baara-anaj*' and therefore do not have to rely on any one single crop. Through this they are able to get a wide variety of crops, which fulfills their need of necessary nutrients.

The available land quality in the region is of two types-irrigated and unirrigated land. The type of land with ample scope for irrigation through streams and canals comes under the first category and is used to sow finer grains like wheat, rice etc. The unirrigated land does not have any provision for irrigation and has to depend on natural means like rains. Such type of land is used to grow coarse foodgrains like *kodo/mandua* (finger millet), *jhangora* (barnyard millet) etc. The cycle of crops is so planned by these villagers that no land piece lies vacant. This strategy to cultivate a wide variety of crops helps in providing balanced nutrition and enough foodgrains to the villagers throughout the year by allowing them to make the most of the environments many ecosystems.

Detailed interviews with the people engaged in agricultural practices revealed the traditional methods of land measurement. These included local measurement units like *naali* and *baath*, which were explained in detail by the villagers. Each of them could give an explanation for this practice. One of many such explanations given by a women, Savitri Devi, provides an interesting explanation regarding the measurement of 1 *naali* land. According to her roughly some 4 seeds are to be sown in an area equal to the size of a foot of an ox. She could not give any perfect reason for this behavior yet was confident of it being a reliable form of knowledge as it was continuously used by the villagers in their activities.

On observation it was found that these villagers do not have any absolute form of knowledge. Their information system continuously evolves as per their needs and the prevailing conditions. The role of women in these agricultural operations is also very significant and their contribution works out to be more than three-fourths of the labour required for these works. The women participate in almost all agricultural activities like

land preparation, manuring, sowing, weeding, harvesting, threshing, carrying the produce from farm to home, storage of foodgrains etc.

An observation of the agricultural tools used by the villagers revealed their vast knowledge about the variety of wood to be used, the height and length of the tool and so on. While making their traditional plough the villagers use wood from Baanj tree to make the lowest part called as *Nisdaa*. As told by a villager Ramesh Chandra the reason for using the wood of this specific tree is that it is very hard and does not break easily while digging the soil.

Due to lack of irrigation facilities and rocky terrain, most of the cultivated area is not irrigated in the region. The village included in the study also does not have any natural irrigation source such as a river or stream etc. According to the villagers they are forced to rely on rainwater for the irrigation of their fields. More than 80% of the total land is cropped for the foodgrains. The villagers grow grains and vegetables in their land most of which is for personal consumption. Amongst the crops they also plant some fruit trees as well for their personal consumption. Through their observation and innovative capacities, these people have been able to evolve their economic activities and management strategies to suit the characteristics of their specific natural environment.

The folk knowledge system of the Garhwali villagers serves its purpose in an economically viable manner as compared to the modern technological advancements, which has a very easy access to the resources. Hundreds of years of experience of the community is seen in their everyday practices such as terracing of farmlands, construction of houses with sloped roofs, use of *pathals* in roof making and so on. Scientists have failed many times to prove the scientific nature of such indigenous practices. Perhaps the undocumented nature of the indigenous strategies give a chance to the scientists to call it as an 'unscientific' approach. The indigenous knowledge is based on the perception and interpretation style of the natives while some behavioral patterns are also guided by the religious beliefs of the community. Shiva (1988) expressed the view that traditional subsistence methods are based on bodies of knowledge that have evolved through trial and error over the centuries and are highly adaptive to the specific situations and are sustainable without long-term damage to the land.

All human beings share a symbiotic relationship with the culture wherein they are situated. People shape their own culture, which in turn guides their perceptions, interpretations and actions. In the present study it is seen that the geo-physical conditions of the region makes life hard and difficult for the people. Yet it does not cause the migration of people from the region. The community has managed to develop its own indigenous ways of doing their everyday activities and has adapted to its surroundings in an effective manner. Their methods are not dependent on the market-based resources. The villagers keep in mind the local and easily availability of the resources along with the surrounding conditions while developing these methods. These practices make the community a 'closed' group, which is self reliant in meeting the needs of its inhabitants.

Transmission of knowledge and development of skills in the garhwali community takes place through experience and learning by doing. Interviews with the villagers showed that the children or novices have to pass through a series of stages before getting formally induction into the mainstream work. According to the villagers a child is first engaged in some odd jobs like getting fodder for the bullocks, cleaning them, tilling the small leftover corners of the field and so on. When the elders are convinced that he is able to do them properly, then only he will be asked to start ploughing and do other important jobs. Behind such a practice their idea is to make the child learn while he actually participates in the activity. They have full belief in the capacity of the child but it is their idea that learning can take place only in a specific way. Therefore it is compulsory for all the children to take part in the activity, which they want to learn.

The sample activities of house construction and agricultural practices and tool making which were observed as a part of this study convey the idea that there exists some type of relationship between these practices and the surrounding ecological factors in the region. The narration provided by one villager Mr. Rajendra Prasad Kala reveals the underlying logic behind using pathals in making the roof of the house. He said that it keeps the house warm in winters and cool in summers. His disgust is evident in his narration, as now forcefully he and other villagers have to use tin sheet roofs due to the existing situations. Their cropping pattern is shaped entirely on the basis of prevailing ecological conditions in the region. Mountain agriculture is an apt example of 'nature-subsidized' agro system which relies on natural resources for its working. It relies on the

sunlight, rainfall, crop residue etc. and is controlled by ecological principles thus embracing the feature of sustainability. It can be therefore be inferred from the aforesaid discussion that invention of specific indigenous strategies by the garhwali villagers was the main reason for their successful and fearless stay in the tough Himalayan terrains.

CHAPTER 5-CONCLUSION

This study was undertaken to explore the scientific and mathematical concepts embedded in the every day cultural activities of the Garhwali villagers in Uttarakhand. Each culture adapts to the environment in its own unique style that is specific to their groups' norms and beliefs. The availability of resources and the ecological conditions influence actions undertaken by the natives in doing their mundane activities. The desire to explore the indigenous knowledge of people living in traditional Garhwali community especially in the area of science and mathematics motivated the researcher to undertake this study.

The objective of doing this study was to explore the scientific and mathematical concepts embedded in the everyday activities of the Garhwali villagers. The study also examined the notional understanding of these physico-mathematical concepts by these villagers. For this purpose, initially, a pilot study was conducted in the month of October that helped the researcher in familiarizing with the area and the people. It also immensely helped in checking the loopholes in the checklist of questions that was used for data collection in the final study. The main study was conducted in the month of February and March. The researcher stayed in the field for a period of little more than a month. Detailed interviews were conducted with all those people engaged in the sample activities along with the audio recording. These interviews were later transcribed and then categorized so as to analyze the data for research findings.

The results showed that the villagers in the Garhwali community, in their everyday activities like house construction, agriculture etc. deal with numerous scientific and mathematical concepts. They use the locally available resources to face the extreme climatic conditions prevailing in the region and to adopt a decent life style for themselves. They, therefore engage in complex multivariate judgments using their folk knowledge.

The traditional Garhwali community performs their basic activities in mutual consultation and harmony. Issues, big and small, keep on cropping and community members resolve them with the help of each other. Mutual consultation is a routine that is accorded a very high importance in the community. The elders or the experienced community members contribute with their age-old experiences and understanding of the surroundings. Everybody in the village feels free in asking them for suggestions. They are able to help the villagers to think about all the pros and cons and then take a wise decision. Each member of the community has to undergo a very hard life due to the tough geographical conditions of the region. The same work if done in the plains would require fewer amounts

of strategic planning, money and time. But, in the hills, the conditions are different. There are no vast plain grounds. The availability of resources is scarce and it is also not very easy to avail the facility from the cities due to lack of continuous and good transportation facilities.

Due to these reasons, the community largely practices self-sufficiency and makes skilled use of the resources available around them. In ancient times, the villagers themselves made almost all the necessary items. The old system was basically for livelihood purposes and was not used as an opportunity for earning money. Barter was a fundamental livelihood strategy and people used it so as to boost mutual exchange of goods and services in order to live a balanced life. Another strategy was to cultivate as wide range of crops as possible. This practice helped in protecting them against the risk of crop failures and also allowed them to avail the most out of their surrounding environment.

In the Garhwali community, the people count, measure and deal while doing their mundane jobs. For this purpose they have their own methods and terms, which they apply while working. For example, while doing their everyday activities they use two local measurement units of 'Maana' and 'Paantha' to measure any commodity. These two units form the basis for all their larger measurements as well. Similarly for land measurement, they use 'Naali' and 'Baath' instead of universal units like hectare. Their house construction practices include measurement by hands, palms, fingers etc. These people have their own understanding of these concepts, which may not be logical or scientific in nature, but it helps them a lot in dealing with their environment. Because of their familiarity with the traditional methods the villagers find them more easy and comfortable to use and hence prefer them to the popular modern methods.

While doing their agricultural activities, the garhwali villagers make use of traditional plough and other tools such as *kutli*, *dandla* etc. These tools are specifically designed by them keeping in mind the prevailing ecological and geophysical conditions, which affect the existence of people in this region. Their tools are found to be lower in height than the ones found in the plains. The researcher on investigation found that the garhwali villagers take extreme care while designing and making their tools and constantly keep in mind the low height of the natives and animals found in the region. Today even after the introduction of modern technology and equipments, the Garhwali villagers still prefer to use their ancient traditional methods. It is so because these tools and equipments were made specifically for their region. They are not mass-produced and hence the villagers feel more comfortable in using them. The modern technology is universal in nature and hence does not answer the specific problems faced by the community. Traditional, age-old tools are designed to suite the prevalent conditions and hence are widely popular among the natives.

During the study, the researcher also observed the house construction process in the region and found it to be an elaborate and time taking practice. The strong and massive structure of the

houses found in this region require a lot of time and man power which makes it a community process. The villagers use *pathals* and stones in constructing their houses, which reflect judicious application of locally available resources in their effort to adapt well to their environment. The villagers have their own notional understanding of the concept of slope, force, angle etc. that is frequently applied by them while doing their everyday activities.

The knowledge base of these everyday practices may be informal in nature but it makes the villagers confident enough to deal with the surroundings. These practices are a part of their community level interaction with the surroundings. All their daily needs are met in this manner. As only the men do ploughing in fields hence they plough the fields of widows by themselves and do not expect anything in return. Such is the sense of responsibility among the people. Every body's work is done without any need to look for outside help. Beginning from the house construction to agriculture or any other work, the entire village comes together to get the job done.

The present study supports the view of the researchers in the past, which considered knowledge as a social construct. Knowledge is a collection of an individual's perception of his surroundings and the various ideas, which he develops, in this interactional process. This local knowledge is based on age-old practices, which are developed keeping in consideration social, political, economic, ecological as well as cultural factors. All these factors lead to the conception of various culturally specific ideas or beliefs. which guides the natives in doing their everyday activities. Science and mathematics are socially developed phenomena, which help an individual to function optimally in his environment.

IMPLICATIONS OF THE STUDY

Therefore it is beyond imagination to introduce a new agro-pastoral technique or any new concept without taking into consideration the villagers' local knowledge of the ecology, botany and agriculture that forms their ideas of doing agriculture and helps him in the management of resources. The knowledge base, which guides the every day functioning of the inhabitants, is based on fundamental popular pragmatism. It did not crop up in one single moment rather continuous sessions of interactions were needed in shaping them. Introduction of any new policy be it in the area of education, agriculture, housing etc should essentially be grounded in the local knowledge base. It is so because local villagers understand this form of knowledge the best. Any idea that is devoid of it may not appeal to them. Something that deals in their terms, ideas and values is more easily acceptable to them rather than the modern scientific ideas that appear 'Greek' to them. Even though

they may be aware of these scientific concepts yet the difference in expression may abstain them from adopting them.

There is need for us to make use of this rich cultural heritage in enriching our educational practices. Our present school system does not recognize the traditional knowledge as valid owing to its informal nature. The existing wide gap between the traditional everyday life activities and classroom teaching practices is largely responsible for making learning process more of a burden for the learner. From textbook examples, to the language used in them everything is so alien to the child's own world that he or she finds it difficult to associate with them. Such a system demarcates between knowledge acquisition and real life processes. It thus introduces the child to a formal, alien and sophisticated way of dealing with practical life situations.

Studies done in the past have repeatedly emphasized the need to carefully consider the content and language of the textbooks. An inadequate textbook remains incomprehensible for the learners thus demoralizing them in their quest for knowledge acquisition. In 1999, Mary Harris (on behalf of the commonwealth secretariat) undertook a study of the mathematics textbooks and teacher's manuals in order to identify the apparent gender bias in NCERT books. In her findings she found considerable lack of examples of women being engaged in mathematical activities. To convey her idea, Harris gave a classic example in which she says that an illiterate village woman carrying milk also has some sort of understanding about the quantity of the milk, its worth in terms of money and for how many people that quantity will suffice. Her knowledge may not be formal in nature yet it helps her in carrying out the mathematical calculations while doing her everyday activities. Harris, therefore, beckons the curriculum framers to take into account this informal yet useful knowledge system so that the textbooks can be made more interesting and friendly for the learners. On the same lines in India, we can cite the example of 'AYURVEDA' which is an ancient and effective form of medical treatment. The knowledge of biodiversity helps in identifying the herbs and forms the basis of this system. This treatment method has gained immense popularity around the globe yet in our own country we have failed to realize the importance of its knowledge base, that is, the rich, traditional knowledge.

Rampal, Ramanujam and Saraswathi (1998) in their book 'Numeracy Counts' have indicated towards the active participation of people, and women in particular, in complex mathematical calculation while doing their everyday activities. There is need to club together both indigenous and conventional classroom based knowledge systems while framing our educational practices. Such an arrangement would allow a child to take active participation in classroom activities along with making the optimal use of his innate reasoning capacities. The child can easily comprehend the knowledge acquired in such a manner and further apply it in practical real life situations. Rampal

(2003) in her article "Counting on Everyday Mathematics" has emphasized the need of careful and adequate usage of folk and street mathematics in the process of learning.

The people in traditional communities develop their own methods of estimation and measurements, which help them in making accurate judgments during their daily transactions. But when the same person attends school, then the kind of textbook content seems to be uninteresting and incomprehensible to him due to its unfamiliarity with his previously learned ideas. The process of knowledge acquisition should be such that it enriches a child's worldly expanse rather than uprooting him of his cultural identity. The inaccurate and inappropriate yet popular conceptions of knowledge are the main cause behind the unpopular status of indigenous knowledge. There is need to make teachers sensitive towards the needs and experiences of the children. Teachers should be trained to appreciate the responses of child that includes examples from his real life situations. Such motivation in the classroom would help the child in comprehending his school-based knowledge easily and more effectively. Acknowledgement of this local information system by the teacher can make the classroom atmosphere more interactive and productive and motivate the child to take active participation in classroom activities. There is a need to preserve and enrich such indigenous forms of knowledge and use them in our teaching practices. The sense of familiarity people share with them will surely assist in their learning of the modern, conventional mathematics as well.

The present study does not claim to have explored all everyday activities of the garhwali villagers. Only some activities could be explored to elicit the embedded scientific concepts in them. Various limitations were responsible for this limited approach, which included shortage of time as well as paucity of funds. This study being qualitative in nature, it took a lot of time in visiting the place, talking to the villagers, recording and transcribing the data. It would have been good if the researcher could stay in the field for a longer period so that process of meaning making in the traditional garhwali community could be studied. It would have been useful to study the effect of local knowledge on the school based learning of the garhwali children. The information about the kind of relationship they both share could help a lot in formulating specific teaching practices for the region. Despite the aforesaid limitations, the study fulfills its job satisfactorily. The findings can be of immense use for the future researches undertaken in the field of education and cognitive development, which attempt to study knowledge as a social construct.

BIBLIOGRAPHY

- Adler Jill (1997), 'A Participatory- Inquiring Approach' *Educational studies in Mathematics*, Vol. 33 (No. 1-3)
- Aggarwal I.C. and Aggrawal S.P (1995), ' Uttarakhand (Past, Present and Future), Concept Publishing Company, New Delhi.
- Anghilero Julies (1989), ' An investigation of young children's understanding of multiplication.' *Educational studies in Mathematics*, Vol. 20, 307-385.
- Balokhara Jag Mohan and Chittoria Navin Kumar (2003),'Uttaranchal- An Informative Manual'. H.G. Publications, New Delhi.
- Banerjee Mrinmayi (2004),' Personality and Ethnicity-Psychological Unveiling,' Anthropological survey of India.
- Barnhardt R and Kawagley A.O. (2005)'Indigenous Knowledge Systems/Alaska Native Ways of Knowing' *Anthropology and Education Quarterly*, 36(1), 8-23.
- Barton Bill (1996),' Making sense of Ethno mathematics: Ethno-mathematics is making sense' *Educational studies in Mathematics*, Vol. 31, 201-233.
- Bennet Judith (2003)'Teaching and Learning Science', Bookcraft (Bath) Ltd.
- Brenner Mary E. (1998),'Meaning and Money.' *Educational studies in Mathematics* Vol. 36, 123-155.
- Bishop Alan J. (1988), ' Mathematics education in its cultural context.' *Educational studies in Mathematics* Vol. 19, 119-191.
- Boaler Jo. (1983), 'Encouraging the transfer of 'School' Mathematics to the 'Real World' through the integration of process and context and cultural. *Educational studies in Mathematics* Vol. 25, 341-373.
- Boaler Jo (1999),'Participation, Knowledge and Beliefs: A Community Perspective on Mathematics learning. *Educational studies in Mathematics*, Vol. 40 (No. 1-3), 259.
- Bose A. (2000),' Ecology, Economy and Society in Himalayan villages.' *Economic and Political Weekly*. July 2000, 2707-2709.
- Bruner J.S. (1960), " The Process of Education', Harvard University press, PG 45.
- Bruner J.S., Oliver R.R. and Greenfield Patricia M. etal (1966), 'Studies in Cognitive Growth (A collaboration at the Centre for Cognitive studies), John Wiley and sons. Inc.
- Byers and Ercwanger (1984), 'Context and Form in Mathematics.' *Educational Studies in Mathematics*, Vol. 15, 259-275.

- Childs and Greenfield Marks (1980), ' Informal modes of learning and teaching: The case of Zinacanteo Weaving Studies in Cross-cultural Psychology Vol. 2, Neil Warren edited, Academic press Inc, (London) Ltd.
- Chevalard Yvers (1990),' On Mathematics Education and culture Critical After thoughts.' Educational Studies in Mathematics Vol. 21, 3-27.
- Cohen Sheila and Cohen Robert (1982), ' Distance Estimates of children as a function of type of activity in the environment.' Child Development, vol 53, 834-837.
- Cole Michael, Gay John, Filick Joseph A., Sharp Donald W. (1971), ' The Cultural Context of learning and Thinking an exploration in Experiment Anthropology. ' Methuer and Co. Ltd. London.
- Connors Jeanne (1990), ' When Mathematics meets Anthropology The need for Inter disciplinary dialogue. " Educational Studies in mathematics Vol. 21. 461-469.
- Davis G.E. and Hunting Robert Paul (1990) Spontaneous Partitioning: Pre-Schoolers and Discrete items Educational Studies in Mathematics. Vol. 21, 367-374.
- Davis and Pepper (1992) Mathematical Problem Solving by Pre-School Children. Educational Studies in Mathematics Vol. 23, 397-415.
- Dugan Benedict (1994),'Simula and Small talk: A Social and Political History', available at <http://www.cebollita.org/dugan/history.html>
- Flick Uwe edited 'The psychology of the Social,'Cambridge University Press, 1998, Pg. 41-59.
- Gates Peter (2001),'Issues in Mathematics Teaching,'Routledge Falmer, New York.
- Gauvain M. and Cole M. edited (1993) Readings on the Development of Children, Scientific American Books.
- Gerdes Paulus (1988) On Cultures, Geometrical Thinking and Mathematics education. *Educational studies in Mathematics*, Vol. 19, 137-162.
- Doshi S.L and Jain P.C. (2001) Social Anthropology, Rawat Publication Jaipur and New Delhi.
- Hazen Nancy L. (1982), ' Individual and Development differences in very young children. Child Development Vol. 53, 826-833.
- Hiebert J and Carpenter Thomas P. (1982), ' Piagetian Tasks as Readiness Measures in Mathematics Instruction: A Critical Review,' Educational Studies in Mathematics Vol. 13, 329-345.
- Hodgson Susan M., Teresa Rasamound and Ursine Sonia (1999),' Mathematical Modelling: The interaction of culture and Practice.'Educational Studies in Mathematics. Vol. 39 (No. 1-3), 167-183.

- Hollister Elizabeth, Sandberg and Hutten Loches Janeller and Newtomb Noro (1996), ' The Development of Hierarchical Representation of Two Dimensional space.' *Child Development*. Vol. 67, 721-739.
- Hurlock Elizabeth B. (1978), ' *Child Development*' McGraw Hill. Inc.
- ' Inspecting Everyday Mathematics: reexamining culture- Cognition relations'- Books Review (1991) *Educational studies in Mathematics* Vol. 22, 481-490.
- Joshi M.P. (1990),' *Uttaranchal Himalayas (An Essay in Historical Anthropology)* Shree Almora Book Depot, Almora.
- Jurdak Murad and Shahin Iman (2001), ' Problem Solving Activity in the workplace and the school; the case of constructing solids.' *Educational studies in Mathematics* Vol 47, 297-315.
- Khanduri Bijay K. (2000), ' Role of Women in Agriculture and allied activities: A Sociological study of Garhwal region Unpublished Phd. Thesis. H.N.B. Garhwal University Press.
- Leder Gilah C. (1992), ' Mathematics Before Formal Schooling.' *Educational Studies in Mathematics* Vol. 23, 383-396.
- Lerman Stephen (2001), 'Cultural, Discursive Psychology: A Socio-cultural approach to studying the teaching and learning of Mathematics' *Educational studies in Mathematics* Vol; 46, 87-113.
- Levine Murray and Perkins David V. (1987), ' *Principles of Community Psychology (Perspectives and Applications,* ' Oxford University Press Inc.)
- Marzolf Donald P. and De Loache Hudy S. (1994), ' Transfer in Young children's Understanding f Spatial Representations' *Child Development*, Vol. 65 (No. 1-2)
- Masingila Joanna O., Davidenko Susana and Wisniowska Ewa Prus. (1996), ' Mathematics learning and Practice In. and out of School: A Framework for connecting these experiences. ' *Educational studies in Mathematics* Vol. 31, 175-200.
- Mc Shane John (1991), ' *Cognitive Development (An Information Processing Approach),*' Basil Blakwell Ltd. Chapter 6 and 1.
- Mishra Anil K. (2002), ' Role of Community Institutions in Common Property Resources Management: A Study in Sociology of Natural resources in Uttaranchal. Unpublished PhD. Thesis H.N.B. Garhwal University, Srinagar, Sociology.
- Mehta G.S. (1996), ' *Uttarakhand- Prospects of development* Indus Publishing Company, New Delhi.
- Neuman Dagmar (1999), 'Early learning and Awareness of Division: A Phenomenographic Approach. ' *Educational studies in Mathematics*. Vol 40, 101-128.

- Nunes Terezinha and Bryant Peter (1996), 'Children doing Mathematics', Blackwell Publishers Ltd., U.S.A.
- Nunez Rafeal E. Edwards Laurice D and Matos Joas Filipe (1999), 'Embodied Cognition as Grounding for Situatedness and context in Mathematics Education. *Educational Studies in Mathematics*, Vol. 39 (No. 1-3)
- Panda Minati ZHCES, JNU (2004), ' Why don't Saoras Mass produce their agricultural tools? Cultural Situatedness of Physics- Mathematical Concepts. Proceedings of International Conference on "Cognitive Sciences", Elsevier, Paris (In Press)
- Pasnak Robert and Howe Mark L. Edited, ' Emerging Themes in Cognitive Development Vol. II Competencies, 1993. Springer Verlag New York Inc., Chapter 5.
- Pierre-Jean and Sardan Olivier de (2005), 'Anthropology and Development', Zed Books Ltd., London, pg.153-161.
- Potter Jonathan and Wetherll Margaret (1987), ' Discourse and Social Psychology (Beyond Attitudes and Behavior) Sage Publications Ltd. London.
- Posner Jill K. (1982). ' The Development of Mathematical knowledge in two West African Societies.' *Child Development* Vol. 53 (No. 1-3)
- Pozzi Stefans, Noss Richard and Hoyles Celia (1998), " Tools in Practice, Mathematics in Use. *Educational Studies in Mathematics* Vol. 36, 105-122.
- Rampal Anita (2003), 'Counting on Everyday Mathematics,' in Saraswathi T.S.edited *Cross–Cultural Perspectives in Human Development*, Sage Publications India Ltd., pg.326-353.
- Ratner Carl (1991), " Vygotsky's Socio-Historical Psychology and Its Contemporary Applications, Plenum Press, New York, 1991.
- Rogoff Barbara and Lave Jean edited, ' Everyday Cognition: Its Development in Social Context', Harvard university Press. U.S.A (1984)
- Sarkar Amitabha and Dasgupta Samira, ' Ethno-Ecology of Indian tribes,' Rawat Publications Jaipur and New Delhi, 2000.
- Saraswathi T.S. edited, ' Cross- Cultural Perspective in Human Development (Theory, Research and Applications), ' Sage Publications, 2003.
- Schiralli and Sinclair (2002). ' A Constructive Response to 'Where Mathematics comes from.' *Educational Studies in Mathematics*. Vol. 52 (No. 1-3)
- Semis Giin R. and Fiedler Klaus edited, ' Applied Social Psychology, ' Safe Publications Ltd., 1996, 410-412.
- Shipley Elizabeth and Shepperson Barbara (1990), ' Countable Entities Development Changes,' *Cognition* Vol.34, 109-136.

- Shweder Richard A. and Levine Robert A. edited,' Culture Theory (Essay on Mind, Self and Emotion)', Cambridge University Press, 1984.
- Starkey Prentice, Spelke Elizabeth S. and Gelman Rochel (1990), ' Numerical Abstraction by Human Infants'. Cognition Vol 36, 97-127.
- Stigler James W. Shweder Richard A. and Herdt Gilbert edited, ' Cultural Psychology- Essay on Comparative Human Development, Cambridge University Press. 1990.
- Saxe Geoffery B. (1990),' Cultural and Cognitive Development: Studies in Mathematical Understanding. Lawrence Erlbarurn Press, Hill. date, NJ, 236.
- Taylor Nick (1991), ' Independence and Interdependence: Analytical Vectors for defining the mathematics curriculum of schools in am democratic society. Educational Studies in Mathematics Vol. 22, 103-123.
- Taylor Peter Charles (1996), ' Mathematics IN and OUT of school' Educational studies in Mathematics Vol. 31 (No. 1-4)
- Wedge Tine (1999),' to know or Not to know- Mathematics That is a Question of context.' Educational studies in Mathematics, Vol.39 (No. 1-3)
- Wynn Karen (1990),' Children Understanding of Counting Mathematics, Vol. 39. (No. 1-3)
- Yang Matzu Lin and Cobb Paul (1995), ' A Cross-Cultural Investigation into the Development of place- Value concepts of children in Taiwan and the united states'. Educational studies in Mathematics. Vol. 28, 1-33.

