CULTURE, ARTIFACTS AND MEANING MAKING IN SCIENCE:

A STUDY OF TWO COMMUNITIES IN UTTARANCHAL

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Submitted by

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DECLARATION

I, **Himani Pasbola**, declare that the thesis titled, "**CULTURE, ARTIFACTS AND MEANING MAKING IN SCIENCE : A STUDY OF TWO COMMUNITIES IN UTTARANCHAL**" submitted for the degree of **DOCTOR OF PHILOSOPHY (Ph.D)** is my original work. It has not been submitted so far, in part or full, for any degree or diploma in this University or any other University.

(Himani Pasbola)

CERTIFICATE

We recommend that this thesis may be placed before the examiners for their consideration for the award of Ph.D degree of this University.

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WITH GRATITUDE TO

THE ALMIGHTY,

THE SUPREME POWER

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CONTENTS

ABSTRACT

The present research explores everyday knowledge of scientific ideas and practices of the Garhwali and the Jaunsari communities of Garhwal region and their relationship with their eco-cultural systems. It studies how Garhwalis and Jaunsaris organize their scientific knowledge and ideas in everyday life; how different eco-cultural concepts and artifacts mediate everyday knowledge and practices of science in these two communities; and how distributed these cognitions are and how individuals use them to carry out a cognitive task.

Focused ethnography is used for the study. Two ethnographic tools were primarily used for data collection: non participant observation technique and semi-structured interview. Two communities, the Garhwali and Jaunsari from Tehri Garhwal were studied. Three different cultural activities, namely, house construction, agricultural tools and the locally available hydro- based mill called *gharaat* were identified for the study on the basis of maximum participation by community members in these activities that involved some scientific ideas in its making as well as functioning.

The analysis of data shows that the Garhwali natives deal with numerous scientific concepts and ideas while doing everyday activities. These ideas are embedded in their cultural activities. For example, the idea of measurement is tied to the tools that are used for it. *Haath*(hand) is a widely used unit of measurement for length in the Garhwal region and therefore replaces the concept length many times at the lexical level. In house construction, agricultural practices or any other work, length is measured using *haath* and *mutthi*. Similarly, the villagers referred to the concept of equilibrium as *santulan*, angle as *lambaii* and force/pressure as *jor*. The imagination of these concepts is linked to these names.

Analysis of house construction shows a symbiotic relationship between these scientific practices and the surrounding ecological factors. The villagers make packed walls with big

boulders and small stones in a manner that at the time of earth quake it sways as a single unit. Similarly, the villagers had notional understanding of the thermal conductivity of dense materials, passive cooling and thermal lag however they referred to them using different terms. The villagers understood the relationship between height, length and width of the house in the context of area and weight. Similarly, the making of the locally available hydro- based grinding mill, *gharaat* uses law of conservation of energy. The villagers exhibited a deep understanding of the relationship between the quality of the millstone and the force generated by falling of water from a height in converting these into kinetic forces that runs the grinding mill. In the domain force distribution, the villagers show deep knowledge. Instead of using separate pillars to share the force of heavy roof on the walls, cross sectional wooden beams called *sahwaan* are placed across the rooms of these houses which not only convert the large amount of vertical force into horizontal one but also distributes it uniformly between all four walls.

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 based on market -based resources. The villagers keep in mind the local and easy 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 in a large way. Mountain agricultural system is holistic and adaptive to the local needs. Multi-cropping is practiced which provides nutrition from various sources, reduces dependence on any one crop and, also helps to make the most out of the eco system. Women folk constitute almost three fourth of the work force required for agriculture. They take part in almost all the activities. The villagers had extensive knowledge of the locally available wood and other resources and used it for making of tools, houses and parts of *gharaat.*

The folk knowledge system of the villagers serves its purpose in an economically viable manner as compared to the modern technological advancements. Mutual, consultation and

harmony are accorded very high place in the community practices. The entire village works in collaboration and share the workload, be it house construction, agriculture or any other work. Traditional knowledge is transmitted orally as well as through practice from generation to generation. Traditional knowledge acquired over centuries result from a combinatorial work of the villagers using their rich experiences with the surrounding environment and the resources.

The findings of the study have policy implications for developing inclusive curriculum and classroom pedagogy for school and higher education. It offers a potential to bring in traditional knowledge of the people about more holistic and resistant agricultural practices, how to build earthquake resistant houses, how to regulate room temperatures without using any external source of heating and cooling, how to run the grinding mill with natural resources etc. into official discourse on ecology, knowledge and human practices.

LIST OF ABBREVIATIONS/LOCAL TERMS

Haath/Hand which is equal to 18 inch or 1.5 feet approximately

Muthhi is equivalent to a fist / 45 feet/ 15 square gaj

Santulan means balance or equilibrium

Jor means pressure

Bhaar means weight

Dwar are horizontal wooden beams which form a base for roof laying

Satir are stone extensions used to distribute the vertical force into horizontal one

Sahwaan are additional wooden support to the sloped pathaal roof

Pathaal are stone slabs procured from the mountains and used for house construction

Tibaari is the extension of house or living room

Gundiyaa is the local instrument used to make straight walls in a house

Gharaat is the local hydro- based water mill

Patnaala is the tubular passage through which water falls on the wheel of a gharaat

Some local units of measurement-

1 Paantha is equal to 4 ser

1 Maana is equal to 1 ser/ 1/2 kg

1 Naali is equal to 16 mutthi/240sq gaj/ 720ft

1 Gaj is equal to 3 ft/36 inch/ 90cms

Naali is the most popular unit in which people deal while referring to land holdings

1 Baath is equivalent to 2.5 Naali

1 Tokari is equal to 4 Paantha

1 Duun is equal to 16 Paantha

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CHAPTER 1

INTRODUCTION

Ideas and knowledge are constructed collaboratively by human beings. The process of knowledge construction is a dynamic one, involving several mediational tools and artefacts. The knowledge created is transferred from one generation to another through several intergenerational collective actions organised around the everyday needs of the community by its members. Basic socio-cognitive skills like observation, creative imitation, experimentation, and collaborative participation help the members of a community engage with concepts and ideas together for solving everyday problems. The knowledge produced in the process is available in two major forms: tacit and dynamic and is often resilient and environment friendly.

The tacit knowledge produced by a community is often passed on to the next generation through an intergenerational dialogue and engagement where the adults who are generally perceived as more knowledgeable provide some kind of apprenticeship to the younger generation. Culturally valued knowledge on house construction, measurements, agricultural practices etc. are passed on to the next generation through a process of participation in these activities. While the pedagogy of learning in school is more didactic and explicit, the pedagogy of community learning is of participation, self- discovery, and apprenticeship.

The present study builds on research conducted in the past in the Garhwal region (Pasbola, 2005). The study by Pasbola (2005) explored the scientific and mathematical concepts embedded in the everyday activities of Garhwali villagers. The present study extends this work and explores the role of cultural artifacts and everyday practices in the construction of ideas and knowledge amongst the natives. An attempt is made to understand how Garhwalis and Jaunsaris organise their scientific knowledge and ideas in everyday life activities.

Mountains – being natural geographic barriers – have been historically considered more isolated from external forces than other ecosystems. The altitude and steep terrain make mountain communities relatively inaccessible, a factor that inimitably shapes the lives and livelihoods of mountain inhabitants. Geographic inaccessibility has evolutionarily and historically played a very important role in the lives of mountain folk. Since time immemorial, mountain inhabitants have made their living through subsistence farming, pastoral activities, and barter, strategies that are more or less harmoniously aligned with local ecological systems and resources. The strategies and techniques used by natives to carry out daily activities involve a lot of culture-specific thinking within the available resources. The traditional methods used by these indigenous peoples to manage their social and natural environment have gained considerable mainstream recognition in the past some years. This study aims to explore the everyday cultural artifacts and practices of the Garhwali community in order to decipher their impact on the construction of scientific ideas/concepts by the community members.

The discursive practices employed by people to achieve social, cognitive and intellectual goals within particular contexts reflects their subjective need for survival with the available resources and acts as a force which binds people in a culture. Many empirical works on the role of culture in cognitive development have demonstrated the role of everyday knowledge in the process of learning. Learning and knowing are integrally and inherently situated in the everyday world of human activity (Wilson, 1993, pp.71). Varela (1990) asserted that cognition cannot be appropriately understood without taking into account everyday knowledge on the physical and social history of any group. Psychological systems such as categorisation, rationalisation, justification, attribution, and replication provide ways through which people manage their everyday activities and associated meanings.

There exists a reciprocal relationship between the knowledge produced by individuals and the social conditions they are subject to. Such dependence of psychological phenomena on the

practical social world is called 'praxis' or '***tatigkeit***' in German or '***deyatelnost'*** in Russian. Knowledge reflects the socio-cultural reality of the environment in which it is situated. Human beings bestow meaning to various things and situations in their day-to-day activities through their culture. Shweder (1990) has expressed that the quest for meaning or intentionality lies at the core of any culture. Meanings form the most fundamental aspect of a human social setting; they comprise cognitive categories that shape one's actions and view of reality. Life experiences generate meaning, which in turn provide explanation and guidance for these experiences (Chen, 2001). A triad of thoughts, words, and actions, meanings are constructs which explain human interactions with their surroundings. They vary with time, groups, and activities, thus giving rise to new meanings. Meaning can be inferred from words in conjunction with associated activities and context.

Wittgenstein termed life activities as a collective behaviour and put forward his idea that psychological activities can be defined best in the language, games etc. prevalent in a particular society. It was his argument that the meaning of any psychological concept depends upon its functional role in the society. To quote Wittgenstein, "the meaning of a word is its use in the language and not in the description of the word." in Budd,1989, p.21). The concept of situated cognition as proposed by Lave and Wenger (1991) brings together the elements of cognition, perception, and action within the context of the lived world of people. The influence of John Dewey is seen in the work done by Lave, who stated that learning is a resultant of experience and social interaction.

Our everyday experiences are transferred into a culture-specific knowledge base through the process of thinking/meaning making. As rightly put forward by Dewey, thinking involves the extraction, refinement, and manufacturing of knowledge by the people; a process that could be opined as technological in nature. Science and technology as socially developed phenomena aid an individual to function optimally and comfortably in their surroundings. Science is

pragmatic experimentation by the natives in their quest to find solutions to their everyday problems. Technology signifies the active and judicious use of productive skills in the best possible manner in a particular context. In the 1990s, the idea of co-production of science and society evolved. The inference was that science generates tools about nature. Both create affordances for each other for growth. The everyday knowledge (the scientific ideas embedded in the everyday practices of people) provides foundational logic to scientific growth and science makes the everyday life of people ample. When science creates unethical and unsustainable practices, it turns to the everyday knowledge base for corrections. It's therefore important to investigate both the tacit and dynamic knowledge of people and bring that to official discourse so that it maintains a field of tension and challenge for the formal scientific knowledge.

The members of the Garhwali community deal with various scientific ideas which they developed in their quest for sustenance with the help of available resources. Some of these ideas are present in tacit form while other ideas are present in dynamic form. This study explores the scientific ideas available in tacit forms as they are already embedded in the cultural practices of Garhwali people. The members of this community learn these ideas by participating in those everyday activities and develop an intuitive knowledge about the functioning of those. Their knowledge remains in the form of loosely defined everyday concepts which are accessible to them in the form of intuitive knowledge. This study examines the relationship between the ecological contexts of people and the kind of scientific ideas available with the Garhwali villagers .

INDIGENOUS OR TRADITIONAL KNOWLEDGE

A Social constructionist approach emphasizes social construction of knowledge by actively engaging with the social reality. Furthermore, knowledge is subject to interpretation, and the opinion of everyone counts in the framing of a local truth. It is very difficult for outsiders to understand local truths and belief systems because of their ignorance of the cultural background and/or the language that informs them.

Kuhn termed this notion "incommensurability of paradigms". According to social constructionism, diversity of opinion is more important than its correctness. Modern astrophysics is in no way advanced to caveman knowledge of astronomy in this approach. Local knowledge is produced by native communities on the basis of shared history and social consciousness. It may not be reflective of the real world but local knowledge is the ultimate truth for its members and is honoured within the traditions of the communities it exists in. Outsiders must respect a local person's belief system even though they may not believe in it themselves because belief fulfills a cultural need and performs a cultural function.

Traditional knowledge is an active form of knowledge that has been conceived, sustained, and transferred through generations; it is culturally representative of a community. It is a collection of information, innovations, and practices of indigenous and local communities across the world. Orally transmitted from generation to generation, traditional knowledge is the result of the experiences of community members with their local environment and resources. Often acquired over centuries, it is an informal collection of information which is owned collectively by the entire community and is found in the form of cultural beliefs, values, stories, folklore, proverbs, rituals, agricultural practices, and local artifacts, etc. Traditional knowledge is typically practical in nature; it finds its usage mainly in everyday activities in the fields of agriculture, forestry, health, horticulture, etc.

The uniqueness of indigenous knowledge lies in its effectiveness. The apprentice first observes the entire activity be it agriculture, house construction etc. from the periphery. This is a long-drawn process and is spread across several years and provides several opportunities to learn. Gradually the apprentice gets inducted to do the main job and learn through practice. But all this does not happen without the able guidance of the village experts. Through this type of teaching, knowledge and technology are successfully disseminated. The village experts ensure effective transmission of knowledge by repetitive actions so that both the learning process and memory of the lessons are long lasting. This type of knowledge transmission guarantees the survival of technology or knowledge without any written instruction; the end result is reliable and effective for the community.

Indigenous knowledge is holistic, functional, and adaptive to the changes in the social and natural environment; it is transmitted across thousands of years and numerous generations. Very often, indigenous forms of knowledge have been dismissed as unsystematic and incompetent in meeting the economic growth requisites of the modern world. Since time immemorial, modern societies have looked down upon indigenous people and their traditions as less progressive. As a result, many groups of indigenous people –especially those among younger generations – devalue their culture and are highly influenced to adopt new lifestyles and technologies. A large number of indigenous groups have also suffered from long-term discrimination, inequity, and exclusion from the planning and execution of developmental programs and projects (Van Camp, pers, comm, International Conference on Indigenous Knowledge Systems, 21-23 Nov.2005, Brussels, Belgium).

The term “ethno- sciences” refers to the set of concepts, presuppositions, and theories that are unique to each cultural group in the world (Meehan, 1980). The evolution of these systems took place over centuries as a result of the communities’ struggle to resist the many challenges in their immediate surroundings. Cultural backgrounds are highly important in the process of

learning because ethnic, social, linguistic, racial, religious, and social differences can create a disconnect that very often leads to demotivating a child from learning. Each ethnic group has its own mechanism to exploit nature, one which is decisive in shaping the culture of the ethnic group. Ecology provides the base for technology. It is the interaction of culture and ecology that decides the technological capacity of all human groups.

For a very long time, the attitude of Western Science was that Traditional knowledge Systems seem to be mere superstition. After long periods of non-recognition, indigenous knowledge systems ultimately got recognised for their scientific innovation, values, and benefits. They have now earned the validation and approval of the international scientific community.

The present study aims at making the implicit knowledge of everyday artifacts and practices explicit such that these cultural artifacts and practices can be used as part of the classroom learning paradigm. Additionally it aims to challenge the commonly held belief that there is no formal science to be learnt from everyday activities.

In order to avoid a state of frustration in the learner as well as the instructor, the true worth of indigenous knowledge needs to be realised by applying it to explore the implicit potential of the child. In a community, a practice develops as per the needs of the people and the availability of resources. Framing it as informal non-science would be demeaning the intellect that went into its conception. The present study is an attempt to reduce the gap between classroom learning and community learning and also to explore how indigenous people internalize higher psychological functions.

SCIENCE, TECHNOLOGY AND INDIGENOUS KNOWLEDGE

People in traditional societies possess indigenous knowledge which helps them in a variety of everyday activities like curing ailments, using irrigation facilities, managing natural disasters,

tool manufacture and use, etc. These people produce local knowledge in their effort to deal with the surroundings with the help of locally available resources. Among the villagers, the accrual of such knowledge and technology is nothing but a way of life.

Technologies and techniques are a part of the various components of a society; one cannot study them without taking into account the cultural and social background. Ethno-physiography, ethnobiology and other forms of ethnoscience help to explore the meanings of folk names and categories used to refer to landscape, plants, and animals in different cultures. This local knowledge is based on age-old practices developed through trial and error, keeping in consideration social, political, economic, ecological as well as cultural factors. The knowledge base of these everyday practices may be informal in nature but keeps the villagers confident enough to deal with their surroundings and meet all their daily needs.

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. We all grow up with an idea that 'science' is something abstract that a scientist does sitting in his laboratory, where he conducts experiments and makes new discoveries away from the real world. However with the adoption of the Kuhnian concept, it became possible to explore various ways in which science and mathematics are understood in different cultures and the reasons responsible for adopting such methods. Kuhn's theory of the history of science (1962) allows us to see the development of new scientific values and information in the light of changes in the larger world where science is situated e.g. economics, politics, religion etc. Delving deep into scientific history, we come across several such examples of technological advancements that were not born out of conventional scientific methods.

The history of human civilization and technological advancement has been closely linked with man's ability to measure accurately. Measurement affects human lives in many ways in the areas of trade, tool making, farming, healthcare, etc. just being few of them. One of the essential requirements for a meaningful measurement is that it should be acceptable to all in the specific context.

Einstein (1950) said that everyday knowledge provides a huge store of useful metaphors and ideas. From everyday knowledge, the scientist makes a free selection of a set of axioms and there upon begins constructing a theory. Einstein, roots his own intellectual development not in science/ mathematics, but rather in everyday ideas of rigidity, simultaneity and measurement. (Einstein, 1950; Wertheimer, 1982; Miller, 1986).

Sociologists, historians, and anthropologists who have studied the nature of scientific knowledge (Latour, 1987; Knorr, 1981) report that its properties arise from social practices enacted by specific scientific communities. Scientific knowledge, therefore, is not a type of new knowledge, but a refined product for which prior knowledge supplied the raw materials and social interaction supplied the tools. It is therefore argued that everyday knowledge needs to be studied more carefully in order to examine the foundational logic of many scientific inventions done by simple village people.

TRANSMISSION OF KNOWLEDGE IN TRADITIONAL SOCIETIES

Vygotsky's main concern as a researcher was to unravel the intricacies of the learning process. He argued that all types of learning are facilitated with the help of instructions from expert elders and peers. The general theories and methods related to the cognitive development of children assumed that knowing and doing were two separate entities, and treated knowledge as an integral, self-sufficient substance theoretically independent of the situations in which it is learned (Brown, Collins, and Duguid,1989). Vygotsky (1986) took a stand against the

dominant internalist perspective on child development and stood by Weber and Durkheim who stressed the importance of society to personality development. According to him, an individual undergoes cognitive development, with the cognitive structures that eventually develop having a historical and a cultural base. They have existed in society for a long time and are either directly or indirectly transmitted into the minds of growing children by experts through a systematic process.

Other cultural psychologists such as Cole (1980), Shore (1996), Wertsch (1985),Shweder (1991), Donald (1991) and Wells (1999) also favoured growth of the human mind in terms of adopting historically and culturally established knowledge systems. The concept of culture which emerged from Vygotsky's work gained further propagation in the works of other researchers such as Jerome Bruner, Michael Cole and Gardner.

Gardner's view of 'distributed intellect' within the environment also supports the contextualized view of intelligence, where knowledge and knowledge acquisition processes are situated in the culture (Panda M, 2004; Panda, 2006). Such culture-specific forms of cognitive development take place during interactions among the natives while participating in various cultural activities. Callanan and Oakes (1992) have shown that the questions asked by the children regarding 'Why' and "How a thing is done?" are mostly asked during everyday activities shared by an adult and a child. Adults are the primary source of information and knowledge for children when it comes to their culture (Nelson, 2003). Therefore, the manner in which children attend to and interpret the instructions and explanations of adults is very important. Children try to interpret this information package as per their previously acquired mental framework and knowledge base, thus integrating the newly acquired knowledge into the existing structural framework. Vygotsky (1997) called this internalization, a time- intensive process which passes through various stages.

Astington and Olson (1995) came up with an alternative to the acquisition of a theory of mind through the concept of 'enculturation' which refers to the internalization of the indigenous psychological processes by a child in a specific culture. The basic difference was that while acquiring the theory of mind, the child constructs concepts; in 'enculturation' he/she internalizes social understanding. A number of other approaches also recognise the importance of social interaction in development (Cole, 1992; Rogoff, 1997, 98). Social interaction varies across cultures, with reference to its type, level, involvement of people etc. In that case, knowledge systems reliant on specific types of social interaction can be considered as intrinsic to particular cultural groups, thus rendering an equal level of validity to all available knowledge systems. The present study draws it's rationale from Vygotsky's critique of internalist perspective and operates within the paradigm of distributed cognition and role of collaboration in learning and creation.

CULTURAL ARTIFACTS

Cultural artifacts play a major role in mediating human mind and action. All cultural artifacts are human inventions that help human beings carry out everyday activities. Ilyenkov (1977, 1979) proposed the dual material-conceptual nature of artifacts, which was majorly inspired by the works of Marx and Hegel. John Dewey (1891) came up with his idea that described an artifact as the historically modified aspect of the material world created with the aim of fulfilling goal directed activities. Cultural artifacts represent earlier solutions to similar situations by people, which are modified, extended, refined and applied by later generations to new problems and situations.

An artifact adopts its nature – conceptual and material –according to the actions it performs. According to Wertch (1984,1985) human action does not take place in isolation; it often

involves the usage of means such as tools and language. Tools form a subcategory of artifacts. Therefore whenever we study mental functions, the focus should not be just on the person in action but the person engaged in action in conjunction with their means.

Artifacts can be called conceptual because their material form eventually comes up in the process of their participation in the day- to -day interactions in the community which they previously helped to conduct and now which they mediate in present. They are essentially socio-historical in nature, transforming with the ideas of their designers and the later users as per their needs and circumstances. They form and are formed by the practices of their use and by related practices in historical and future communities. (Brown and Duguid, 1994; Gauvain, 1993; Nicolopoulou, 1997; Rogoff et al., 1994).

The invention of tools is a subjective response of the individual to his need for survival. After making a particular type of tool, the individual reflects on its general features and develops a concept. This developed concept is later put in use to organise human behaviour. The realization amongst people that we need a tool is further worked upon and leads to the discovery of a specific and particular tool.

Marx Wartofsky (1973) provides us a more vivid description of artifacts (including tools and language) in his three-level hierarchy and explains them as objects of human desires which develop in the context of culture and beliefs. He comes up with three levels of artifacts: primary artifacts, secondary artifacts, and tertiary artifacts. A major question that arises after this categorization is how artifacts existing at these three levels come together to produce culture-specific human behaviour.

Engestrom (1987) argues that symbols are socio-historically produced cultural artifacts that are formed as a matter of interaction between the individual and the environment. This environment is both human as well as physical which include materials of tradition, institutions,

as well as local surroundings. Discursive processes help in transforming prior knowledge into refined concepts that can be applied consistently by members of the scientific community. Cole and Griffin (1980) and Wertch (1991) said that artifacts serve to amplify as well as constrain the possibilities of human activity as the artifacts participate in the practices in which they are employed. The present study assumes that the cultural artifacts like grinding mill, house construction, agricultural practices are mediated by many cultural concepts like *bhaar, santulan,* etc.. These cultural artifacts in return influence the cultural concepts at various levels. The concept of holistic and sustainable farming continues to influence the agricultural practices of the people.

EVERYDAY CONCEPTS AND SCIENTIFIC CONCEPTS

If one looks at the concepts that one encounters in life, one finds two kinds of concepts: every day and scientific. The concepts that people encounter in daily life are generally loosely defined concepts that describes few properties of the object that it refers to. Scientific concepts, on the contrary, are the ones that develop through a process of deliberation. Human mind and knowledge are shaped by both every day and scientific concepts. As Vygotsky puts it, the scientific concepts develop from everyday concepts but they go through a process of formal deliberation. These concepts are more theoretical. Once children develop scientific concepts, their new acquired knowledge reorganises their everyday knowledge.

Concepts are important as they determine what one knows, believes in, and the way one acts in various circumstances. Children in their cultural setting tend to pick up on conceptual complexes which are to a large extent transferred to them by the experts or learned elders. These words or concepts, to a considerable extent, have a pre-assigned meaning attached to them which are largely culture-specific. Young children, in their need to behave adequately, usually absorb these culturally transmitted meanings without achieving deep conceptual

understanding. Both biological and experiential maturity marks a considerable change in an individual's access to knowledge. Initially, the knowledge base is heavily procedural because it is basically transmitted without the underlying logic. Clifford Geertz (1973) opined that the brain is "thoroughly dependent upon cultural resources for its very operation and those resources are, consequently, not adjuncts to but constituents of mental activity…"

Bruner (1966) proposed that cognitive development or thinking was nothing else but an appropriate categorization of any event or situation by natives. According to him, these categories consisted of a set of events which could be clubbed together by the thinking mind owing to some similar features. Bruner however, made it clear that these categories do not exist in the environment but are socially constructed by the human mind. The inference gained by the thinking mind helps an individual in creating a new category and further assists him in classifying an event relative to the existing categories. Gardner's view of 'Distributed intellect' within the environment supports the contextualised view of intelligence and rejects the isolated view. Knowledge and knowledge acquisition processes are situated in the culture. (Panda M,2004).

Vygotsky's argument was that a major portion of knowledge is acquired in informal settings outside the school. The concepts acquired in the formal setting of school were coined as scientific concepts by Vygotsky (1986) while those acquired as part of daily life were termed as everyday concepts. Every day concepts are acquired by the children/novice in their interaction with adults/experts in their daily life and cultural setting. They may be technical, social, organisational, or cultural in nature and are obtained as a part of the great human experiment of survival and development.

According to Vygotsky, (1986) scientific concepts are more formal forms of knowledge transmitted to the child in a school setting. It has a hierarchical, logically organised format.

though somewhat conservative in approach owing to its pre predesigned format. Scientific concepts can seem too sophisticated – or even alien – to children, especially considering how the understanding of numerical concepts is a function of age and educational development (Hurlock Elizabeth, 1978). Vygotsky, in his Socio-Historical Theory of Development (1978) argued that people in primitive societies have their own numerical system to help count larger quantities of objects. He gives the example of the Papuas of New Guinea, who used an indigenous method of counting in which they used their fingers and other parts of the body as symbols for objects.

A child's own conceptualization of the world through spontaneous concepts gradually merges with that of expert adults in a formal school atmosphere giving them a potentially better and more reliable understanding of the surroundings. In a typical classroom setting of our education system, there is hardly any collaboration in knowledge production. Students act as passive members of a classroom and are largely absent in terms of interaction. One can make them respectable and proud participants in knowledge production in the formal classroom setting by acknowledging the everyday knowledge and making everyday knowledge available for scientific inquiry.

THEORETICAL FRAMEWORK

The following theoretical frameworks provide the base for this study. The intent is to explore the area broadly without being limited by domains of inquiry, with a motive to affirm that everyday artifacts and activities are also a major source of scientific learning.

VYGOTSKIAN APPROACH

Vygotsky's socio-cultural theory of Cognitive Development (1934) is the main theory on which the current study is based. Vygotsky maintained a broader view of human developmental processes emphasising the role of culture in cognitive development as compared to other

theorists. In his view, no single principle such as Piaget's concept of Equilibration can account for the development pattern of humans.

Activity theory based on the work done by Vygotsky and his colleague Aleksey Leontiev in the 1920's strongly advocates a relationship between human activities and the psychological phenomenon in an environmental context. The theory proposes that higher mental processes in any individual find their origin in the social processes in which they play an active role. Social processes actively modify the stimulus situation in the process of people responding to it and analyse human beings and their social systems in their natural habitats through the study of their activities. (Kaptelinin and Nardi,2006). Vygotsky found that all human activities are grounded in a social context where multiple factors like cultural and religious practices, tools, available resources, etc. act as mediators for the construction of thoughts/ideas.

Vygotsky defined 'development' as the transformation of social relations into mental functions. Vygotsky's line of thought is highly influenced by Marx, who emphasized the role of human capacity for tool use and production. "To understand human beings we need to understand history and the dynamics of historical change" (Marx, 1845; Marx and Engels, 1846). According to Marx, people come together to make tools and use them so as to exploit their surrounding environment, thus satisfying their needs.

Community members make use of various culturally available tools and symbols as mediators, to convert social relations into mental functions. Language helps in the acquisition of higher mental processes; people across different cultures are found to classify things differently. Diversity of symbols leads to differences in kinds of mental functions which develop, implying that no universal stages of development can be identified. Friedrich Engels (1925) strongly advocated that the early technology and early tool use form the platform for the distinguished human traits of advanced intellect and knowledge base.

Vygotsky supported Engel's views about tools and their usage in a cultural setting and further elaborated upon it. Vygotsky elaborated on this idea of tools as fundamental to humans and concluded that it not only helps in dealing effectively with the environment, but also affects the internal and functional relationships that exist within the brain. These findings of Engels and Vygotsky found support in the works of archaeologists and physical anthropologists like Leakeys and Sherwood Washburn when they advocated the importance of everyday simple tools in human evolution.

The social cognition learning model asserts culture as the chief determinant of an individual's development. Human beings are the only species to have a culture, and every human child's learning development is affected in many ways by it. The culture an individual is exposed to provides the requisite processes or means i.e. the tools of intellectual adaptation for thinking. According to the social cognition learning model, culture teaches an individual what and how to think. Cognitive development is the result of a dialectical process where a child learns through problem-solving experiences with a more experienced person, usually a parent or teacher but sometimes a sibling or peer. Initially the experienced individual assumes most of the responsibility for guiding the problem-solving, gradually transferring this responsibility to the child over time. Internalisation enables learning by which knowledge and tools of thought that first exist outside are taken in by a child; language plays a major role in this transmission. The difference between what a child can do on his own and what the child can do with help from experienced adults is known as the zone of proximal development.

Much of learning - both in adults and children - comes from the surrounding culture. Furthermore, since all or most of the problem solving is mediated through an expert's help therefore it is not right to focus on learning in isolation. A child's intellectual development is the net result of his effective interaction with adults and the surrounding environment. Since children learn largely through interaction with their earlier knowledge, curriculums must be

designed in a manner so as to emphasize maximum interaction between learners and learning tasks. With appropriate adult help, children can often perform tasks that they are incapable of completing on their own. Through scaffolding, the adult continuously adjusts the level of help in response to the child's level of performance/learning. Time and time again, scaffolding proves to be an effective form of teaching as it produces immediate results and also instils the required skills for independent problem-solving in the future.

BRUNER'S APPROACH

According to Bruner (1966), cognitive growth involves the interaction between basic human capabilities and the socially developed contextual symbols/tools which help to enhance these capabilities. He agreed with Vygotsky and gave importance to the surrounding environment in the process of learning, saying that language acts as a mediator in the development of thought processes. According to Bruner, the outcome of cognitive development is thinking. Unlike Piaget, however, he did emphasize that these stages were age-dependent or invariant.

Bruner's ideas bear a lot of resemblance to those of Vygotsky when he says that members of different cultures exhibit different kinds of reasoning and inference as per their social setting. The term 'categorisation' forms an integral part of Bruner's views on human cognitive activity. According to him, cognition is the process of building and using representations so as to make sense of the surrounding world. When we come across new information in our daily lives, we tend to organise them in pre-existing categories. In case if they do not fit into any existing categories, new ones are created on the basis of available knowledge on what comes close to it. The present study draws it' s foundation from these theoretical frameworks and is an attempt

to explore the mediational role of the eco-cultural factors along with the artifacts on the everyday knowledge and scientific understanding amongst the community members.

NEED FOR THE STUDY

Various studies done in the past have shown that learning depends on the availability, relevance, utility, and social acceptability of any object, tool or idea in a particular cultural setting. The occasions and conditions for the use of a tool arise directly out of the context of activities in which the natives use it. Knowledge comes coded by and connected to the activity and environment in which it is developed; it is spread across its component parts, some of which are in the mind and some in the material world.

A study that was conducted as the M. Phil research work by the researcher (Pasbola,2005) provides the basis for the present study. An attempt was made in that study to explore the various everyday activities of the Garhwali villagers in order to elicit the physico- mathematical concepts embedded in them. The villagers have been known to make their living through subsistence farming, pastoral activities, barter, all or most of which comprise strategies focused on local ecological systems and resources. Findings of the study done by Pasbola (2004) revealed logical setting and implicit scientific and mathematical concepts embedded in the everyday practices of the Garhwali community. Though the villagers were not able to articulate it well, their practices based on their indigenous knowledge reflect a systematic and region-specific approach to carry out day to day activities. This study revealed that many scientific ideas are used frequently by the villagers in their everyday activities and their understanding of them was empirically bounded.

The present study builds upon the previous findings and aims to explore how community members develop their understanding of various scientific concepts and the role every day concepts play in the understanding of these concepts. The study also expounds upon the role

culture plays in the cognitive processes that lead to the acquisition of this knowledge base by children. The specific objectives of the study are as follows:

1. To study how Garhwalis and Jaunsaris organise their scientific knowledge and ideas in everyday life.

2. To study how different eco-cultural concepts and artifacts mediate everyday knowledge and practices of science in these two communities.

3. To study how distributed these cognitions are and how individuals use them to carry out a cognitive task.

Following are some of the scientific concepts along with their local terms as referred by the Garhwali villagers in their everyday activities.

BHAAR (literally equals to the term 'weight' but used by the community to describe FORCE)

Force, as a scientific concept, refers to any influence that tends to change the state of rest or the uniform motion in a straight line of a body. The action of an unbalanced or resultant force results in the acceleration of a body in the direction of action of the force; if the body is unable to move freely, it may result in its deformation. Force is a vector quantity, possessing both magnitude and direction. Therefore while selecting a material for a particular job, it is very necessary to know how it reacts when different types of forces act on it i.e. the mechanical properties it possesses.

'*JOR*' is the word used in the community to articulate the concept of PRESSURE

Pressure is the 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 is great enough to press the tracks into the ground, thus deforming it. The placing of broad wooden sleepers distributes the vertical pressure on the rail tracks and converts it into horizontal pressure, allowing them to retain their original form.

'*SANTULAN*' (closest to the term EQUILIBRIUM/STABILITY/CENTRE OF GRAVITY when articulated by the members of community)

This is the condition of rest or of uniform linear motion of a body on which two or more external forces are acting simultaneously. When the body remains in the state of rest under the influence of applied force, it is in static equilibrium; if it remains in the state of uniform motion, it is in dynamic equilibrium. The larger the force needed to change the state of a body, the more stable its equilibrium. The stability of a body is increased if the mass of the body is large, the area of the base of the body is large, and the centre of gravity is as low as possible.

The neglect of children's everyday knowledge in classroom learning motivated the researcher to take up this study. The society has moved ahead in a post-positivist paradigm. However, our school systems continue to be gripped by the positivistic approach, according to which there exists only one ideal form of knowledge i.e. school, knowledge. All other forms of knowing nature and indigenous knowledge systems are being held as unscientific.

Teaching in a diverse classroom is exceptionally challenging because of the varied background of learners. However, if knowledge acquisition is built on a child's previously formed conceptual networks, it is quite possible to make the teaching and learning experience more enjoyable and enduring. If teachers make use of children's home knowledge for introducing more abstract academic concepts, the children will develop better understanding of the concepts as classroom dialogue becomes more relatable. The present study, therefore, attempts to document and analyse everyday/community activities like measurement systems,

agricultural and house building practices and grinding machines in order to unpack the kind of scientific ideas that are present in these activities.

CHAPTER 2

REVIEW OF LITERATURE

The previous chapter briefly presented the rationale behind this study and what it intends to explore, along with theories wherein the conceptual framework for the study is derived. The present chapter engages with the relevant literature in order to frame research questions and identify methods for undertaking this study.

RELATIONSHIP BETWEEN CULTURE AND HUMAN COGNITION

Psychology and the concept of meaning share a mutually dependent relationship and this relationship has remained consistent since psychology came into existence as an independent discipline. However, with the advent of new schools of thought, the concept of meaning lost its place in the discipline. Since the 60's and 70's the importance of the concept of meaning was felt, as without it the human cognition resembled a computer program, which is devoid of any meaning outside its computational logic.

Russian psychologist Lev Vygotsky (1934), in his socio-cultural theory of human learning, emphasized the role of culture in providing individuals with the 'tools of intellectual adaptation', which plays a major role in cognitive development. His theory implies that all types of human learning is centred around their social interactions within their community with experienced elders, teachers, and peers. Bruner (1966) worked towards and succeeded in aligning meaning with the study of psychological processes. Cognition, therefore, is seen as a complex social phenomenon as against a purely psychological one. It is a diffused phenomenon, not divided between mind, body, activity, and culturally organized settings

(Lave, 1988). Knowledge emanates from people, essentially generated by the individual as a result of their immediate environment; it is also in a permanent state of transience as a result of man's actions.

Culture acts like a lighthouse guiding us in specific ways regarding what to think and how to behave in various life situations. It can be defined as a collection of activities through which an individual expresses himself. Culture assists us in defining ourselves and enables us to be meaningful in communicating with others while managing our physical and social environments. It is through culture that we think, feel, behave and interact with reality (Shweder,1991). These cultural variations have a deep impact on the critical thinking pattern and identity of an individual.

Psychologists interested in culture tend to focus on the extent to which culture varies and how such variation affects not just the superficial content of beliefs and behaviours but the very nature of basic domain general psychological processes, including the self (Markus and Kitayama, 1991;Triandis, 1989), cognition (Medin and Atran, 2004; Nisbett, Peng, Choi and Norenzayan, 2001), attention and perception (Nisbett and Miyamoto, 2005), motivation (Heine, Lehman, Kitayama, and Markus, 1999), and emotion (Mesquita, 2001; Nisbett and Cohen, 1996).

The larger question here is, 'why does culture exist and how does it emerge?' Culture emerges when information is transmitted socially through learning mechanisms such as imitation, mimicry, and instruction (Tomasello, Kruger and Ratner, 1993), as well as through by-products of communicative processes such as gossip, conversations, and storytelling (Schaller,2001). Culture can emerge from local environmental factors acting on a native's thought processes; it can also be transmitted from one mind to another. It is the sense of belongingness to a group that shapes the thought process and belief system of an individual.

Studies done in the past in the area of cognitive development infers that learning is contingent upon social situations. Research in this field can advance only if these social systems are well-connected to the developmental processes which they help to organise and also to the cultural system which provides them with meaning.

Hall (1969) in his book 'The Hidden Dimension' states that culture cannot be fully erased from a person's psyche; it is intrinsically connected to one's physiology. Culture is responsible for determining our specific responses - both verbal and nonverbal - which in turn represent our specific thoughts and feelings and the appropriate moments to express them. Thinking is a complex phenomenon comprising methods of organising and transmitting knowledge and social practices. The degree to which a culture is collectivistic or individualistic has a very deep impact on the thinking skills of the natives. In individualistic cultures, individual goals are given more importance, while group goals are prioritised over individual ones in collectivistic cultures. Social intelligence is accorded a higher place in traditional communities however in modern urban societies, technological advancement gains prominence (Mundy-Castle,1974). In subsistence economies, socialization plays an important role in achieving the goals of survival and sustenance. There is a sharp contrast in the socialisation practises of the industrial urban societies as compared to agriculture based traditional societies. (Toennies,1963).

Cultural symbols are heavily grounded in the particular system where they are situated. Similar forms and symbols may appear in different societies, but the meaning and interpretation would be very specific to a particular environment and place. The contextual existence of a group develops and determines the identity of any individual belonging to it. As such, culture and identity are inseparable. It is only through the combination of various social factors that it

becomes feasible for human beings to understand their intimate link with the web of meanings (Geertz, 1989).

The concept of culture is linked to a hierarchical mode of thinking. Cultural symbols and artifacts accelerate the human imagination and promote higher level thinking. Any creation of mankind is the result of the combined pressures exerted by the socio-cultural environment and the subjective needs of individuals. The conceptualised tools/artifacts find their base rooted in the numerous cultural symbols contextualized by place and time.

Imagination plays an extremely important role in coordinating and expressing human needs through the symbolic activities which represent both the individual psychological level and the much larger cultural/social level manifestations consisting of religion, ritual, language, etc. Imagination is never definitive because of the constant deconstruction and reconstruction it undergoes owing to its dynamic status. It is built on subjective needs of the people that acts as a bridge between the biological/psychic and the social/cultural factors. Therefore, a study of imagination allows us to decipher an individual in a contextualized reality; this also helps us understand the dynamic forms that give form and shape to cultural expressions. The aim of ethnoscience is to analyse how the human species, throughout its evolution, has generated, organised, and divulged arts and techniques with the purpose of understanding, explaining, and dealing with the natural, social, and cultural environment, be it far or near, admitting its right and capacity to modify it (D' Ambrosio, 2004, p. 286).

CULTURE AND ITS IMPACT ON HUMAN LEARNING

Each one of us has a different reason to learn. Some learn to be knowledgeable, some for fun, and some to please their elders and teachers. However, most do it because it is supposed to be done. In order to engage people in learning, it's very important for knowledge to make sense.According to Vygotsky, approaches sensitive to the social and dynamic

dimensions of learning and development, together with the cultural turn in psychology of education (Bruner, 1990; Bruner and Haste, 1987), have progressively redefined learning as a process rather than as an outcome resulting from specific educational interventions. Learning does not take place in isolation under the effect of planned stimulation given to the learner. It is an active process of social interaction in which the individual looks forward to fulfilling culture specific goals with socially available resources.

The process of learning and education requires individuals to think relatively and dynamically about objects of knowledge, different people, and various situations. Learning is typically oriented towards command over shared cultural meanings; however, final impressions depend on the person's sense making of situations and application of the tools and knowledge during them .

Various studies on home knowledge (Moll, Amanti, Neff, and Gonzalez, 1992) youth culture (Habermas ,1996; Heath, 2004; Hundeide, 2005; Perret-Clemont et. al., 2004b), school dropouts (Zittoun, 2004a, 2006a), or street skills (Carraher et al. ,1988; Rogoff, 1993), have recurrently shown that young people and adults learn through many ways in specific relational settings, and about specific objects – which do not always resemble instruction offered by schools. Although the role of cultural elements has been widely acknowledged since the beginning of cultural psychology (Bruner, 1990; Vygotsky, 1971), their impact on the process of learning and development needs more in-depth probing.

To think of a human being's existence in isolation either from his community or group culture is an unimaginable task. The concept of culture has always been an integral part of the imagination one has about the human mind. Culture and Psychology both have had their share of contention as per the interest of contemporary scholars.

Human beings grow and develop in a specific physical, social, and cultural context. In order to survive, man continuously interacts with and alters his environment. The adaptability of people, individually and socially, to naturally or artificially occurring environmental situations is commendable. All such interactions culminate in the creation of things like houses/dwelling units, food habits, weapons and equipment, folklore, etc., which constitute an important part of any culture. All human societies depend upon their accumulated learning or cultural knowledge for their survival.

A child is the future torch bearer for his family and – eventually – culture. Thus, to keep cultural heritage alive, he or she is trained from the very beginning to think and act in a socially acceptable manner. This cultural rootedness of the actions of a child is indicated by Reagan (1996). In order to become a member of the group, a child tries to conform to culturally approved behaviour through the effect of child-rearing practices.

Sullivan (1950) also emphasizes the importance of culture when he said 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), and Gerth and Wright (1970).

Culture guides us through socially approved norms for perceiving the social 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 towards acceptable behaviour. Culture gives direction to our thoughts, perceptions, values, and actions.

Herskovits (1948), an eminent anthropologist emphasised the inclusive role of culture in shaping the behaviour/ideas of the individual. Brislin (1990) puts forward that home designs, layouts of villages, communities and cities, and public buildings and places reflect the values and beliefs of a culture. Houses created by people in different parts of the world differ on the grounds of design, materials used, and ecological context. Likewise, in the case of agriculture, there is a wide variance in the types of crops grown, tools used, and agricultural practices. This ability of human beings to adapt to their environment is exemplary, and is the basis for specific cultural environments.

The aforesaid studies indicate a reciprocal relationship between culture and the human mind. This idea gets its backing from the Vygotskian idea of the social structuring of the human mind. The cultural organization of the human mind is so intense that it regulates all the skills ranging from behavioural to biological as a phenomenon and borrows more from social cognition as opposed to the psychological one. Different cultural prototypes exist for different cultures, and they affect the cognition of children situated in them. Differences exist between cultures because people develop and concentrate on different aspects of the environment, assigning various values and meanings to them.

In the past, academic intelligence reigned supreme because of the popular belief that it is universally applicable in situations as compared to practical, informal knowledge, which lacks generality and is confined to specific contexts. However, this idea was opposed by eminent psychologists such as Ceci and Liker (1986), Goodnow (1986), Scribner (1986), and Anthropologists such as Lave (1988; 1990), who through their studies confirmed that both academic and practical intelligence are interwoven in a social context. That means that socio-cultural background decides the form for 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

also on our involvement with them and other options available in the environment. He gave an excellent example of seaweed, dandelions, etc. which are considered as weeds in France and vegetables in Korea.

CULTURAL ARTIFACTS, KNOWLEDGE AND HUMAN LEARNING

Activity theory, developed initially by Vygotsky, Leont'ev, and Luria (1978) proposes that all interactions done by human beings with their environment takes place with the help of culturally available tools in their context. The theory emphasises that the development of understanding in an individual regarding any activity or tool use should always be rooted in context. This makes the acquisition of knowledge permanent and practically applicable by the person in new situations. (Nardi,1996)

Other than the family, knowledge construction in a child takes place through his or her active participation in formal institutions such as schools, and through observing more competent and expert members of the community as they engage in cognitive activities. Legitimate peripheral participation /LPP elucidates the transition of newcomers to experienced members and then, masters in communities of practice or during collaborative projects (Lave and Wenger, 1991). Learning according to LPP is situated in a social context and is achieved through participation in community practices.

Wenger offered a detailed description of the nature of knowledge that is acquired through participation methods. Knowledge, as per Wenger, consists of four qualities. Firstly, knowledge exists in the human act of knowing. For example, reading about the *gharaat* is very different from being physically involved in its making and operations. The first-hand experience one gets while involved in a procedure is the rarefied knowledge. Secondly,

knowledge is found in two forms, namely, tacit and explicit. More and more informal interactions with experts help evoke the innate knowledge amongst students and children.

Thirdly, knowledge is found in both forms, social and individual. This means that lots of people in a class or community with varied experiences and perspectives on issues add to the richness of discussion and hence build up a knowledge base. Fourthly, Wenger talks about the dynamism of knowledge, implying that it is continuously growing and not stagnant. Wenger asserts that collective knowledge in any field is changing at an accelerating rate. However, one cannot deny the stability of the core knowledge of a community, which acts as a basis for meaningful participation to take place.

LEARNING AND SITUATION ARE INTEGRALLY RELATED

The way each community identifies tools and uses them is a direct indication of the way community members perceive their surroundings. The way they act in certain situations reflects their thinking style. While it is possible for people to have a basic understanding of how to use a tool, its application can vary in different socio-cultural contexts. The same applies for conceptual tools, which are indicative of the cumulative wisdom of a culture and its inhabitants.

Individuals often apply different types of logical and scientific reasoning in school as compared to when at play or doing everyday activities. School woodwork is not carpentry and the sewing done in arts and crafts class does not make the student a tailor. This is because these activities are inevitably separated from all its social elements, needs and goals and so on, those that make tailoring and carpentry a professional art.

Lave (1996) stated that context is an active component of any activity and is therefore mandatory for all researchers to explore during their studies into cognitive development.

Gladwin (1970) in a study on Micronesian navigators found that they had good memory, recall, and calculative powers while performing their regular task of navigating from one island to another, but performed very badly on standardized intelligence tests. The formal knowledge imported in the school is not of much help in real life situations because it is deeply rooted in school culture. Lave (1988) in her study of learning and everyday activity said that a great difference exists between knowledge derived from cultural activities and knowledge that students gain 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, thoughts, and formal principles of teaching. In real world situations, learning takes place on the basis of communally shared ideas, the various practices employed to adapt to the surroundings, and situation-specific activities. Contextual settings help expand the scope of psychology as a discipline since it is possible to explore human thinking as a product of both an individual and his/her socio-cultural, anthropological, and political contexts.

Folklore, mathematics, science, and language, all help in the conception of symbolic systems of knowledge which help a person think and act in accordance to specific situations and activities. 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.

Thinking is a practical activity, engaged in by an individual while adjusting to their surroundings. Suppose a well-educated person with little practical knowledge is asked to work in a shop. He or she may not be very efficient in carrying out such jobs. This is because practical experience is more valuable than formal understanding in such a scenario.

Pea (1988) and Hutchins (in press) supported the situatedness of cognition across physical as well as social environments. This statement can provide some explanation for the individual differences in performance for 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 may seem like only a guideline to the thoughts, feelings and behaviour of people residing in a location. However, if one were to delve deep into it, it can be concluded that culture is the very foundation for the perception, thinking, and actions of individuals. The socio-cultural approaches have highlighted the importance of situations in the learning process.

This symbolic view of Shweder regarding culture bears some similarity with Moscovici's (1984, 1988) idea of social representations, which in itself draws inspiration from Durkheim's (1915) idea of collective representations. Cultural protocols are very important, especially in the area of scientific learning. Until 1950, science was considered a culture-free and value-free discipline. However, research findings in both anthropological as well as cross-cultural studies have indicated that they have cultural backing.

Van Sertima's "Blacks in Science" (1986) is yet another 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 have also fuelled the debate regarding importance of cultural protocols in the learning of science. 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 analyse their problems and interpret them.

Practices, therefore, should be seen as discursive formations within which valid knowledge is produced through successful participation. Lave and Wenger (1991) proposed

that participating in a cultural practice in its contextual setting is 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.

Sciences, as is generally understood nowadays, appeared as a form of understanding, explanation, and adaptation to the natural environment in earlier times. Each community or culture generated knowledge in some particular context with a motivation to solve the concerned problems. This knowledge is open to changes for improvement from time to time, provided it does not affect the cultural heritage. Einstein(1950) has also advocated the importance of everyday knowledge which provides an exhaustive reservoir of useful ideas /metaphors which assist in the learning of science.

Eminent anthropologists such as Fortes (1938) and Lave (1980) have denied the existence of teaching as a distinct activity in traditional societies. Fortes (1938) stated that education in traditional, non-industrial societies involved no systematic or regular pattern of training. In other words, the process of development of understanding about various traditional activities takes place among people as a by-product of cultural practices. The entire process takes place informally, despite the approach being fairly systematic.

Most parent-child interactions are structured such that it promotes the development of social and cognitive skills, even though providing instruction to the child may not be the aim of adults. Fortes(1938) gives the example of the Tale education system, which trains young ones in realistic situations where both the trainers and the trainee participate in the activity to facilitate knowledge transfer. According to him, this transfer of knowledge in a community is seldom regularised, but occurs as a ‘by-product’ of the cultural practices.

Lave and Wenger (1991) came up with the idea known as the concept of community of practice (COP). They observed that in traditional communities, people acquire knowledge

based on their age, level of authority, gender, status etc. This means that a newcomer is not fully inducted into an activity from the onset of their participation.

Vygotsky (1998) advocates participation in different life practices by the individuals as a belief that one cannot undergo cognitive evolution by mimicking or modelling. Kula (1986) provided evidence that the realistic nature and functional methods used for qualitative measurement restricted historians from shifting to modern 'conventional' systems. These methods are grounded in realistic practical experiences of individuals with their surroundings, and hence are more meaningful to users.

An extremely important question which then comes up is, 'how is traditional or everyday knowledge acquired by the individuals?' Scribner and Cole (1973) pointed out that children in modern societies characteristically train in schools, away from the real world. On the contrary, children in traditional societies learn by apprenticing themselves to adults in real work.

White and Siegel (1984) in their article on 'Cognitive Development in Time and Space' mention that children in communities extend their knowledge of the distant past by specialising in specific areas. For example, children who opt for farming learn more about crop loans, commodity markets, agricultural policies, etc.

Extending his description of a development sequence in his study of the Kipsigis system of traditional education in Kenya, Koech (1974) states that children start observing activities before participating in a minor way. Eventually, these children graduate to perform tasks independently.

Lave has termed this as learning by legitimate peripheral participation (LPP), where the child is situated at the periphery of the activity. After children can fully accomplish small

apprenticeship tasks, they are inducted into doing critical tasks. In a nutshell, learning depends on the contextual setting in which the person and the activity is based.

Rogoff (1995) assessed learning as a continuous activity, using the term “participatory appropriation”. This explains the learning process in human beings as a process of active participation in tasks 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 associated knowledge available to fit new problems. The Laboratory of Comparative Human Cognition (1980) credits adults for facilitating the learning process of a child by regulating the difficulty of tasks, communicating well–placed guidelines, and displaying expert, mature performance. They instruct children on tasks and context so that it is easier for them to relate his/her previous learning to the new and novel experiences that come their way.

The structuring of instruction serves as scaffolding for learners, providing a framework for discovering solutions to a problem. A novice mostly acquires skills and knowledge in an informal manner by keenly observing an expert and participating at a comfortable but slightly challenging level.

One example of such educational practices as used by the Guarenos of the Orinoco delta of Venezuela is discussed by Ruddle and Chesterfield (1978). The Guarenos teach cultivation, animal husbandry, hunting, and fishing to children and novices in their community. This mode of instruction is highly systematic and composed of different instruction styles, with the implicit aim of teaching remaining hidden. Children learn in an informal atmosphere with no explicit coercion to learn anything.

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

Lambert (1986) while teaching multiplication to her students connected it with their everyday knowledge. She tried to keep things interesting by incorporating certain anecdotes from their real life practices. The students gained a lot of knowledge while forming connections between knowledge and problem-solving activity. In other words, Lambert was able to bring together the two concepts of knowledge and action. This method allows the students to have more faith and confidence in their implicit traditional knowledge as they become aware of its applicability in real-life situations.

Cognitive Apprenticeship, inspired by the idea of situated learning, involves giving instruction in a situated manner (Collins, Brown and Newman, in press), making the knowledge more accessible and comprehensible to learners. Legitimate Peripheral Participation/LPP propounded by Lave and Wenger (1991) is also a very interesting and important method of instruction whereby the learner does not take part initially, simply trying to understand activities from the periphery. This learning style is important for beginners from the economic

as well as psychological point of view. Firstly, they will not waste any resources or damage tools. Secondly, they will not be nervous suddenly performing tasks independently. An initial introductory phase offers learners enough information about tasks so as to make them confident when they finally take responsibility for critical tasks. Therefore, they observe the adults for a while and then try to imitate them in the best possible manner without any encouragement.

Fortes (1938) commented about imparting education in traditional, non -industrial societies. He reported that these societies did not have any systematic or regular pattern of training young ones. Rather, training took place via regular cultural practices. Lave (1988) and Nunes, Schliemann, and Carraher (1993) found that school imparted knowledge is not universally applicable; it is not superior to everyday knowledge which carries with it a socially constructed meaning, making it more applicable to real-life situations.

We fail to come across systematised knowledge transfer in a traditional society routine, where no formal and systematic arrangements are made by elders to impart local cultural knowledge to younger generations. Instruction is carried out in a trial and error fashion, where understanding is developed about the various traditional activities among younglings. 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 world ‘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 activities in detail. They instead called the modern knowledge system ‘conventional’ owing to its detachment from social context.

In a study on Vai and Gola tailors (Lave, 1988), the author indicated that apprentice tailors were initially asked to iron finished garments. This is not because they are considered

inferior, but because the task familiarises them with the different cuts and folds of garments. This would informally impart the ideas behind tailoring.

Whiting (1964) has explained the causal influences of ecology on culture and personality development and eventually behaviour. He found that the power of parents and other socialising agents in shaping social behaviour; parents are largely responsible for the assignment of tasks to children in different settings. Each setting has its own group of people, in-progress activities, physically defined spaces, and typical norms of behaviour, all of which act as blueprints for propriety in these settings.

Vygotsky(1978) opined that a concept is psychologically represented as word and meaning. According to him, a word itself has no meaning. People in the process of thinking, meaning-making, and communication use words for expressing nuanced ideas. Therefore, words are an important sign of conceptual development. Vygotsky puts across two more phases in the development of thinking towards concepts which helps and motivates the transition to thinking in concepts: pre-concepts and potential concepts. Pre-concepts – according to Vygotsky – mark a specific stage in the generation of concepts, while potential concepts represent pre–intellectual forms of activities. These phases signify the practical part of any situation, object, or event, for example, symbols/signs which are used as a habitual response to any given life situation. That means it could have a functional meaning (LSVCW v.1, p. 158). Pre-concepts are more liable to develop easily in school-going children who are confronted with various school tasks and social activities such as measuring, buying, selling, calculating, etc.

Concepts arise within some specific social practices in the form of a problem and a solution (Vygotsky, v. 1). The development of concepts, in the view of Vygotsky, takes place

in an individual throughout his life; it is a resultant of the intervening effect of thought and language in the mind of the individual.

Learning and acting are instinct. Learning is a continuous, life-long process which occurs by acting in different situations. Knowledge is coded by the activity and environment in which it develops and spreads across in different parts, a part of which is in the mind and other part in the outside world. While Conservation, problem solving, etc. do share some logical similarity, their presence in different tasks and situations makes it difficult for individuals to generalise knowledge learnt in one occasion to other situations. Macquet (1972) differentiated between the concept of universal humanity and specific individuality and said that the culture wherein a person stays marks the formation of a cultural zone, which differs from one culture to another. Researchers like Brainerd (1978), DeLoache and Brown (1979), Feldman(1980), Seigler(1981),Rogoff(1982)emphasized the importance of context in cognitive development without which they noticed a lack of generality of capacities in their studies.

The occasions and conditions for using a tool arise out of the context of activities within the community which uses it. The tool is framed according to the manner in which the community perceives the outside world. That is why a significant difference can be observed in the way a villager designs a plough and how modern ploughs are designed. The indigenously made plough is well-adapted to the environment as it has been designed with the local conditions in mind. The modern technological wonder that is the tractor may be useful in most – but not all – situations.

Similarly, conceptual tools reflect the experiences of individuals and cumulative wisdom of the culture in which they are used. In traditional societies, learning takes place not as a formal separate process, but as practical lessons that are part of life. Such instruction can

be described as a process of learning while doing or ‘on the job training’ in modern terminology. In the latter, training is known and explicit, while in the former learning takes place intuitively and is viewed as a natural phenomenon. This gives the learner first-hand experience of tasks, allowing them to feel confident in applying acquired knowledge in practical life situations.

It is often assumed that the introduction of modern technological inventions in the daily lives of the villagers is a worthwhile and important exercise aimed at improving the lives of villagers. However, modern educators are often ignorant of the embedded scientific and technological concepts in the indigenous practices of villagers. Due to lack of formal school education, villagers are not able to articulate their lack of understanding of the contemporary basis for technological understanding but this does not make their knowledge system inferior in any way.

IMPLICIT KNOWLEDGE OF SCIENCE AND TECHNOLOGY IN INDIGENOUS KNOWLEDGE

People in traditional societies possess indigenous knowledge which helps them in a variety of everyday activities like curing ailments, agriculture, irrigation, disaster management, tool making, etc. These individuals produce local or indigenous knowledge in their effort to thrive in their surroundings with the help of locally available resources.

Technologies and techniques are a part of various processes that take place in a society, which is why one cannot study them without taking into account the cultural and social backgrounds. One effective example of indigenous knowledge use is demonstrated by the Goud and Santhal tribes of India, who prepare an umbrella of teak leaves to protect themselves from the rain. This is such a fine example of rich traditional knowledge helping to protect against natural

phenomena with the help of locally available resources. Ethnoscience or cognitive anthropology expresses how people perceive their surroundings and deal with them. Ethno physiography, ethno biology, etc. are forms of ethnoscience that help explore the meanings of folk names and categories used to refer to landscape, plants, and animals in different cultures.

Science and technology is constantly applied in our everyday activities, albeit not very explicitly. The learning of scientific concepts by children is not independent of the complex social setting in which they are situated. Theoretically, we may term a child's learning of science as a purely cognitive matter; yet, this form of analysis is not quite possible in practice. A child's learning process is not simply a cognitive phenomenon; social factors form the basis for such learning to occur.

Science must be thought of as a way of thinking, not just a discipline. It can be learned formally inside a classroom setting, or informally while doing various social activities like building houses, performing agriculture work, running a watermill, etc.

Almost all everyday activities are based on the laws of geometry, physics, astronomy, etc. representing various technological innovations devised by human beings. However, while performing everyday tasks based on these laws, like transporting goods, flying a kite, etc. one may not be aware of the scientific knowledge on which they are based. Hence, we cannot say that scientific knowledge was consciously used during these activities. It could be argued that many inhabitants of a community are unaware of scientific concepts while executing day-to-day activities. To them, it is only a way of performing tasks, developed by the process of trial and error through their frequent experiences with their surroundings.

Gregory Cajete (2000) identifies the expansive mapping of knowledge as 'Native Science' which according to him is the collective heritage of human experience with the natural world. It is a map of natural reality drawn from the experience of thousands of human

generations while giving rise to diversity of human technologies in many profound ways. It can be said to be “inclusive” of modern science, although most Western scientists would go to great lengths to deny such inclusivity (Cajete, 2000:3).

The cultural context in which groups exist is largely responsible for providing roots to its natives and strengthening them. 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. The review of findings of study by Pasbola(2005) says that the garhwali community performs their basic activities through mutual consultation and harmonious interaction with each other and nature. Despite problems cropping up, community members resolve them amicably with the help of each other. Mutual consultation is a tradition which is accorded a lot of importance within the community.The village elders or experienced community members contribute with their age-old experiences and understanding of their surroundings. They are like information databases that everybody in the village feels free to consult for suggestions in any situation.

The highlanders or the members of mountain communities live a hard life due to the harsh geo-physical conditions of such regions. The availability of resources is scarce and limited and it is also not very easy to avail modern facilities from cities due to lack of continuous and effective transportation connectivity. Because of these reasons, the native communities practice self- sufficiency, making judicious use of the resources available around them. Even after the introduction of modern equipment and technology, the Garhwali and Jaunsari villagers still prefer to use their traditional cultural methods. It is so because these tools and equipment were made specifically for their region; their reliability remains high. They are not mass-produced, but suit the specific needs of individuals living in extreme climatic conditions. Traditional methods and tools are designed to suit the prevalent environmental

conditions. As such, they are widely popular among the local population. Modern technology does not address the specific local problems faced by the community.

Their tools are specifically designed with the prevailing ecological and geophysical conditions in mind. These facts imply that the community largely practices self-sufficiency and makes skilled use of the resources available around them. Since ancient times, the villagers themselves made almost all of the items necessary for sustenance; resources that couldn't be manufactured were bartered for. While this age-old system helps secure a livelihood, it doesn't provide an opportunity to earn profits. Barter is a fundamental livelihood strategy; people often rely on barter to make ends meet. Another strategy employed by the Garhwali and Jaunsari the cultivation of a wide range of crops. This practice helps protect them from the risk of crop failure while also allowing them to avail the most out of their surrounding environment.

The development of conceptual knowledge in any child is the resultant of his/her interaction with their natural surroundings. Therefore when they comprehend everyday scientific phenomena, their explanations are loaded with non-scientific explanations backed by their daily experiences.

When we activate the knowledge previously gathered by students, it gives rise to metacognitive processes which are very important for self -assessment. In order to make learning effective for the students they must "develop the ability to take control of their own learning, consciously define learning goals and monitor their progress in achieving them" (National Research Council, 2005, p. 4-10). Science is defined as an approach to make sense of the natural world, the investigation of nature is only part of the knowledge generation process (Kittleson and Southerland,2004).

One major problem encountered by students in a science classroom is getting acquainted and well-versed in the language of science. Jargon is a big hurdle, if not the biggest

for villagers attempting formalised education. Nearly every form of teaching and learning requires a medium of language, but subjects like science, math etc., which require complex terminology to explain a concept, creates more difficulties for village folk. This is one of the reasons which motivated the researcher to investigate the implication of everyday knowledge of people on classroom pedagogy for science teaching through this study.

SCIENTIFIC CONCEPTS/EVERYDAY CONCEPTS

Vygotsky (1986) puts across four features of scientific concepts which are lacking in spontaneous concepts: generality, systematic organization, conscious awareness, and voluntary control. As Vygotsky puts it, “only within a system can the concept acquire conscious awareness and a voluntary nature. Conscious awareness and the presence of a system are synonyms when we are speaking of concepts.” (DSC, p.191).

Scientific concepts differ from everyday concepts in their basic characteristics and method of acquisition. Everyday concepts are directly related to the world of experience, while scientific concepts are more general and more abstract. Scientific concepts are acquired in an institutional or educational setting through deliberate and systematic modes of instructions. Vygotsky asserts that, “The development of scientific concepts begins with the verbal definition.” (DSC, P.168). Everyday concepts, on the other hand, are acquired by the child in a spontaneous process through the process of social interaction, which happens via engagement and participation in community practices.

Studies on language development of children (Bruner, 1983; Haaliday, 1975; Wells, 1985) have shown that a culture’s language provides as a tool for thinking and communicating

with is appropriated and mastered by the child in the course of innumerable conversations with family members in the context of a wide variety of everyday activities.

While the contribution of adults or older peers to these interactions may or may not have a deliberate instructional purpose, the child's learning of everyday concepts that are encoded in the spoken texts – which they jointly construct – is dependent on 'instruction in the zone of proximal development', much like the learning of the scientific concepts encountered in school(Rogoff and Wertsch, 1984; Wells, 1986; Wells, 1990).

WORDS, PICTURES AND KNOWLEDGE

While language is important to science, it is more reliant on the combination and interaction of words, pictures, diagrams, images, animations, graphs, equations, tables, and charts (Lemke, 1998; Jones, 2000). Such combinations are important in their own way, providing meaning to the phenomenon but not without some limitations. The effect of guiding instructions and practical application in the field of science cannot be understated. When we see phenomena manifesting in front of our eyes, its impact leaves a mark on the human mind.

The importance of learning scientific jargon in order to become science literate has been a point of contention for a long time. Postman and Weingartner, (1971) emphasised the primary role of language in knowledge construction to the extent that they saw all teachers as propagators of subject specific language with very little to teach about the practical world.

This is in total contrast to indigenous knowledge, which is transmitted across generations in native mother tongues, devoid of any flowery language, images, diagrams, or scientific jargon. It finds its relevance in the surrounding cultural and social environment, and is learned through active participation among community members.

One very important question crops up whether we can call such types of knowledge as technological and scientific, which doesn't have a scientific language of its own. Vygotsky opined that language development and conceptual development are interlinked. We require language for thinking and thinking in return needs language. It would be accurate to say that acquisition of language is decisive in the power of reasoning in an individual (Byrne et al., 1994).

Lemke (1987) points out the danger of emphasizing a scientific way of speaking and of the exclusion of a common, everyday way of speaking, suggesting that it may be more useful to help students see how scientific terms developed from everyday ways of seeing and talking about the world. This is an area of concern, particularly while designing curriculum for a multilingual society. Too much emphasis on the accuracy and language protocol of science surely acts as a hurdle for community members and pulls down their performance. Many theorists have raised the concern that the promotion of a language of science may lead to the conception that there is one right way to talk about, and consequently do, science (Lemke, 1990).

When we insist on a fixed and permanent logical interpretation of science, it unintentionally advocates the perfection of science. An insistence that scientific language be careful and precise may send the message that science knowledge is irrefutable, immovable, and representative of ultimate truths, promoting the ideology of the authority of science (Lemke, 1987).

Such a message may lead students to believe that there is complete consensus on scientific issues among members of the scientific community, an idea that philosophers of science, and many scientists, argue is inaccurate (Kuhn, 1962; Laudan, 1984).

For example, when too much emphasis is laid on using a specific form of language for any discipline, it ultimately leads to a breakdown in terms of classroom competence in communication. In the process of integrating into classroom culture, students may lose his/her cultural identity and feel inhibited in identifying with indigenous forms of knowledge. If the students are made to believe that there is a fixed permanent way to express a discipline, they may feel ashamed to relate to their native cultural identity and the concepts that they may have learned in their cultural surroundings.

Time and again, there have been observations on the validity and sanctity of the Indigenous knowledge systems. Some people have questioned the veracity of indigenous knowledge, or challenged the qualifications of community experts who have no apparent scientific training (Apffel-Marglin, 2011; Augustine, 1997; Smith, 2012). Some wonder whether knowledge indigenous to one's locale has any usefulness outside of that limited sphere (Ellen et.al.2000:17).

Earlier, scientists were unaware of the scientific nature of indigenous knowledge and therefore, did not borrow ideas from it for study. Local traditions and practices were considered mere superstition with almost no scientific or logical backing. The Western world of science and technology utterly disregarded this rich pool of knowledge and treated it very unethically, leading to long term damage to indigenous identity and the sense of pride.

All indigenous groups possess oral traditions which serve as the collective memoirs of ethnic, tribal, and kinship groups, a formal "corpus relating to the whole society" (Vansina , 1985, p. 19).

To summarise, traditional knowledge systems consist of culture-specific practices and rituals which are deeply rooted in its ecological surroundings; these systems encompass unique skills and practices. If adhered to properly, indigenous knowledge can help ensure both short-

term and long-term human health, community sustainability, and preservation of unique ecosystems (Apffel-Marglin ,2011; Berkes, 2021).

RATIONALE OF THE STUDY

The review of relevant literature above shows that culture plays an extremely important role in shaping our ideas, thoughts, and behaviour. Studies done in the past have proven that science has a cultural history of their own. Cultural symbols and protocols play an important role in ethnoscience. Tools created by the members of a community reflect the way in which they perceive the outside world and their subjective needs. Studies on child development in socio-cultural context done by Rogoff (1990) and Saxe (1991), and on conceptual development by Hatano (1990), focus on the importance of everyday activities in the cognitive development of children outside of scholastic settings.

Studies have also shown that traditional knowledge is transferred or passed on from adults to children collaboratively 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 meteorological concepts led to the finding that in the beginning, development was ‘anthropomorphic’. It means that during this period when meteorological concepts were not evolved, various body parts were used as different units of measurement; people used palm, fingers, hand etc. as units of measurement while constructing their houses, ploughing their fields, and performing mundane tasks. The traditional system of weights and measures was based on a qualitative approach; it differentiated between different quantities of a commodity on the basis of differences in their quality. Commodities which were of coarse variety were exchanged at higher quantities for lower quantities of a higher quality

commodity. For example the Chinese system kept the cultural background of cognitive evolution in mind while devising their metric system as people were more comfortable with their traditional units of measurement. Hence the government decided to use the same terminology, albeit standardising them according to the modern conventional measurement units. The familiarity of the people with the names of the units made it easier for them to adopt the new system and also for the government to overhaul the existing system.

A revised socio-cultural explanation of psychological phenomena by Vygotsky asserts that individual development should always be analysed in its socio-cultural context (Yong, 1992). Also, learning of science by children can be seen as an active, constructive, and culturally-specific social process. It means that a child's learning process is not entirely a cognitive phenomenon but is also subject to social factors from their own background co-produced learning and cognition.

Inferentially cognitive evolution takes place in an individual by participation under the expert guidance of adults situated in a particular cultural context. Therefore any study on cognition should focus on social, psychological, and ecological factors that are important in its development.

Building on the review of relevant literature, the present study raises following four questions regarding the Garhwali and Jaunsari communities in Uttarakhand:

1. How do cultural artifacts and practices mediate everyday understanding of scientific ideas and concepts?

2. How do different cultural groups organize their everyday concepts and their scientific ideas?

3. How do cultural tools, symbols, social interactions, and material conditions affect the process of knowledge development in the community?

4. What implications does everyday knowledge of people have for classroom pedagogy for science?

The primary objective of this study is to investigate the relationship between various cultural artifacts and practices and the understanding of these scientific ideas and concepts amongst the Garhwali and Jaunsari communities. This study makes a case for the application of everyday life activities in classrooms with the intent to encourage the use of everyday knowledge in classroom pedagogy for teaching science. The next chapter presents the research methods used in carrying out the present study.

CHAPTER-3

RESEARCH METHOD

The review of literature reveals that both cognition and knowledge are products of interactions between socio-cultural environments, human needs, and subjectivity of the people. Human cognition and mind are firmly grounded in various cultural symbols, artifacts, and practices contextualized in place and time. Material and symbolic tools or artifacts are developed and used by communities as an aid to the thinking process and are therefore called tools of thought (Cole; 1996). This study aims to examine how knowledge is constructed in the indigenous communities as individuals participate in their everyday cultural activities, and how available artifacts – both symbolic and material – mediate their cognition and knowledge.

RESEARCH QUESTIONS

The following questions guide formulation of research objectives:

1. How do cultural artifacts and practices mediate everyday understanding of scientific ideas and concepts?
2. How do different cultural groups organise their everyday concepts and scientific ideas?
3. How do cultural tools, symbols, social interactions, and material conditions affect the process of knowledge development in the indigenous community?
4. What implications does everyday knowledge of people have for classroom pedagogy for science?

OBJECTIVES OF THE STUDY

The broad objective of the study is to explore everyday knowledge of scientific ideas

and practices of the Garhwali and the Jaunsari communities of Garhwal region and their relationship with their eco-cultural systems.

The specific objectives of the study are the following:

1. To study how Garhwalis and Jaunsaris organise their scientific knowledge and ideas in everyday life?
2. To study how different eco-cultural concepts and artifacts mediate everyday knowledge and practices of science in these two communities.
3. To study how distributed these cognitions are and how individuals use them to carry out a cognitive task.

RATIONALE FOR THE STUDY

The social institutions, artifacts, and cultural concepts affect the development of knowledge in human beings in a symbiotic manner. Ratner (2001) advocates the need to detect the connection between the details of a person's narrative and macro-cultural factors. According to him, narratives must be treated like fossils which are in dire requisite of interpretation and reconstruction in order to detect the life forms incompletely represented by them.

The various discursive practices in the present study reflect human behaviour narrowing down as we are rather intervening in the everyday practices and not interviewing people in a structured manner. The set of psychological capacities that allow humans to learn from others and calibrate their behaviour to the cultural group they live in are rooted in evolutionary processes. There are already numerous theoretical works, mostly in anthropology, about such capacities (Boyd and Richerson 1985; Richerson and Boyd,2005; in Psychology, see

Tomasello et al. ,1993). A community can be described as a group having:1) common interest amongst people2) a common ecology and locality or,3) a common social system or structure.

Taking these as a base, Frankenberg (1966) proposed that common interests and religious, economic, and social goals bring the members of a community together. Therefore, there is a developed sense of social coherence in a community which binds its members together.

Cultural tools are an important and indispensable part of any complex psychological process. To quote Vygotsky (1930; 1981):

"Mastery of a psychological tool and, through it, mastery of a natural psychological function always raises the particular function to a higher level, increases and widens its activity, and recreates its structure and mechanism." (1930, p.42).

Then comes the concept of the zone of proximal development and its implications on theories of teaching/learning. It works on the assumption that an expert elder can assist the child in performing certain types of tasks, promoting his/her cognitive growth and development by leaps and bounds. This assisted process has been described as scaffolding (Wood, Bruner, and Ross, 1976).

Thus, the knowledge of epistemological perspectives that guides a learner's culture has policy implications for education. The manner in which the learners respond to/participate in a particular phenomenon may be largely influenced by the manner in which the discourse is organised in their community. Cultural protocols are extremely important in the learning of science and mathematics. Research findings in cross-cultural as well as anthropological studies emphasize on their cultural rootedness. Thus, not taking these important cultural perspectives into account is an objectivist approach, which manifests itself through the teaching of science

as a body of objective facts. Overlooking the humanistic aspect of science – with all its inherent cultural biases – may lead to an inaccurate perception of the performance of learners.

RESEARCH DESIGN

Since qualitative research methods provide the respondents with room to offer personal accounts of their attitudes, motivations, perceptions, views, and feelings (Hakim, 1987), the present study utilises its principles to organise the study. Focused ethnography is used to study how community members engage with scientific ideas and concepts, how they talk about tacit knowledge of their lived world, associated scientific ideas and concepts, and how they respond to the eco-cultural demands of their regions in their everyday life.

Selection of Sample and Cultural Activities:

A pilot study was conducted to select both the communities and practices for the study. Two communities, the Garhwali and Jaunsari, were identified from the Garhwal region for this study. The researcher's familiarity with the region and its people guided the decision to study these communities. The cultural activities that were selected for analysis involved house construction, agricultural tool-making, and the locally available hydro-powered mill called *gharaat*. The reasons for selecting these three activities are:

1. Every member of these two communities, Garhwali and Jaunsari were involved in at least one of these three activities.
2. These activities involve some scientific ideas behind its workings.
3. These activities have evolved over several centuries in this region and are central to people's life.
4. These activities throw light on how people develop an understanding of their surrounding world in daily activities.

5. These activities allow one to understand how different communities respond to their eco-cultural systems and beliefs.

A community-level investigation was carried out using focused ethnography to investigate the impact of culture and community on the conceptualisation of scientific concepts and ideas among children and adults. According to Ratner (1997, 2002) and Tamasello (1999), cultural practices exist in three categories: social institutions and policies, physical infrastructure and artifacts, and cultural concepts. As such, an emphasis is placed on studying various cultural artifacts and their effect on the knowledge of the community members about various scientific ideas and concepts.

The Jaunpur block region in Tehri Garhwal district of Uttarakhand has been chosen to conduct this study. The choice was made keeping in view the availability of a sample population and access to it. The state of Uttarakhand comprises a total 13 districts, of which 6 constitute the Kumaon division and the remaining are constituents of the Garhwal division. The people of Uttarakhand come from a diverse ethnic background. It is a multi-ethnic state which includes members of the native Garhwali, Kumaoni, and the Gujjar communities. The Jaunsaris are the notable ethnic group of people living in Uttarakhand. **When residing in the Jaunpur region of Tehri Garhwal, they refer to themselves as the Jaunpuri community, though their cultural traditions and practices remain the same as the Jaunsaris.**

A BRIEF INTRODUCTION OF THE REGIONS UNDER STUDY

The Himalayan range extending across the northern part of the country is known as Uttarakhand**. Previously a part of the larger state of Uttar Pradesh, Uttaranchal became a separate state in November 2000. Further in January 2007, the name of the new state was officially changed from Uttaranchal to Uttarakhand by an Act. Therefore in the present study, the region is referred as Uttarakhand.** The region houses peaks and glaciers,

meadows and valleys. The Garhwal region of Uttarakhand is a land of numerous mountains and lakes with abundant flora and fauna; it is often called the ‘Abode of god’.

Geographical factors have always played a very important role in shaping the history and culture of this region. The successive phases of folding and rising of the Himalayas created new dimensions in the studies of the global mountain system as well as the evolution of human civilization. The state’s climate is quite different compared to other parts of the country due to significant geographical differences. Altitude is an important factor which influences the climate of the region. Different ecological zones favour the growth of specific crops. People plan their lifestyle in accordance with these factors in order to meet their basic needs independently. The mountain folk inhabiting this region are cooperative communities where everyone is ready to help their fellow villagers. A cooperative lifestyle is prioritised such that everyone involved themselves in communal tasks.

The people of Uttarakhand are commonly known as '*paharis*' or the people from the hills. The *paharis* include members of the native Garhwali, Gujjar, and Kumaoni communities. Apart from these communities, a number of immigrants also constitute part of the population. The Bhotias, the Tharus, the Bokshas and the Rajis are other notable ethnic groups of people living in Uttarakhand. A nomadic community of muslims that practices animal husbandry The people of Uttarakhand come from a multi ethnic background they still adhere to their unique culture and traditions. Most of these people reside in rural areas and live in slate-roofed houses, terraced fields and traditional costumes.

Hindi is the most widely spoken language in the state. Other languages prevalent in the state are Garhwali, Kumaoni, and Nepali. Uttarakhand comprises a number of tribal communities, both nomadic and agrarians of Indo-Aryan descent. The people of Uttarakhand constitute various tribal groups amongst whom the Jaunsari are a group of who are classified into two original tribal groups: the Koltas and Khasas. In fact, the Jaunsari are one of the few

communities in the world which follow the polyandrous system where the wives can have more than one husband at a time. More liberal in approach, Jaunsari women enjoy greater freedom to choose and divorce partners. **The Jaunpuris (offshoot of Jaunsaris residing in the Jaunpur block region of Garhwal)** are also famous for their colourful clothes and festivals. The people of Uttarakhand never miss out an opportunity for celebration; they celebrate all the festivals with great enthusiasm. There are so many geo -social factors which influence the culture of the people of Uttarakhand. The bonds between the people are reinforced by features like music, dance and arts and the people are in turn deep -rooted in their relation with awe inspiring Himalayas. The people here generally get very excited about festivals; they actively participate by fasting, joining festival processions, cooking food, etc. Some festivals, customs, and traditions pertaining to the people of Uttarakhand include Basant Panchami, Bhitauli, Harela, Phooldei, Batsavitri, Ganga Dussehra, Dikar Puja, Olgi or Ghee Sankranti, Khatarua, Ghuian Ekadashi, and Ghughutia. The main occupation of the people of Uttarakhand is agriculture; large-scale manufacturing enterprises are rare. Tourism is a crucial economic supplement to the people. The state survives on a money order economy since most skilled youth migrate in search of greener pastures.

INFORMATION ABOUT THE REGION

Village Name	Pantwari
Block	Jaunpur
Post office name	Sigunisera
District	Tehri Garhwal
State	Uttarakhand
Located at a distance of	120 kms from Distict headquartersTehri
Village code	44137
Area	82.79 hectares
Total population	545
Number of Males	286
Number of Females	259
Total Number of Scheduled caste families	105
Literacy rate in the village	65.9%
Total number of literate persons	359
Number of literate males	226
Number of literate females	133

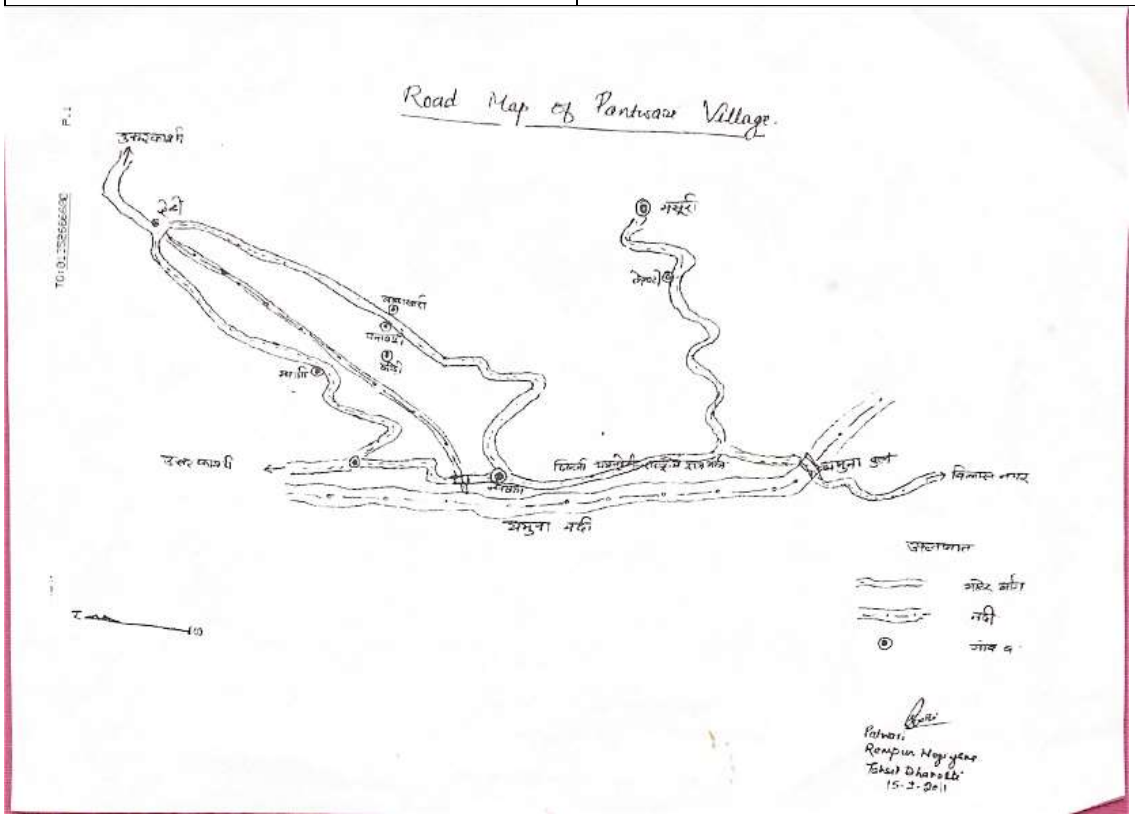


Fig.1.1 ***Road map of the region covered in the study***

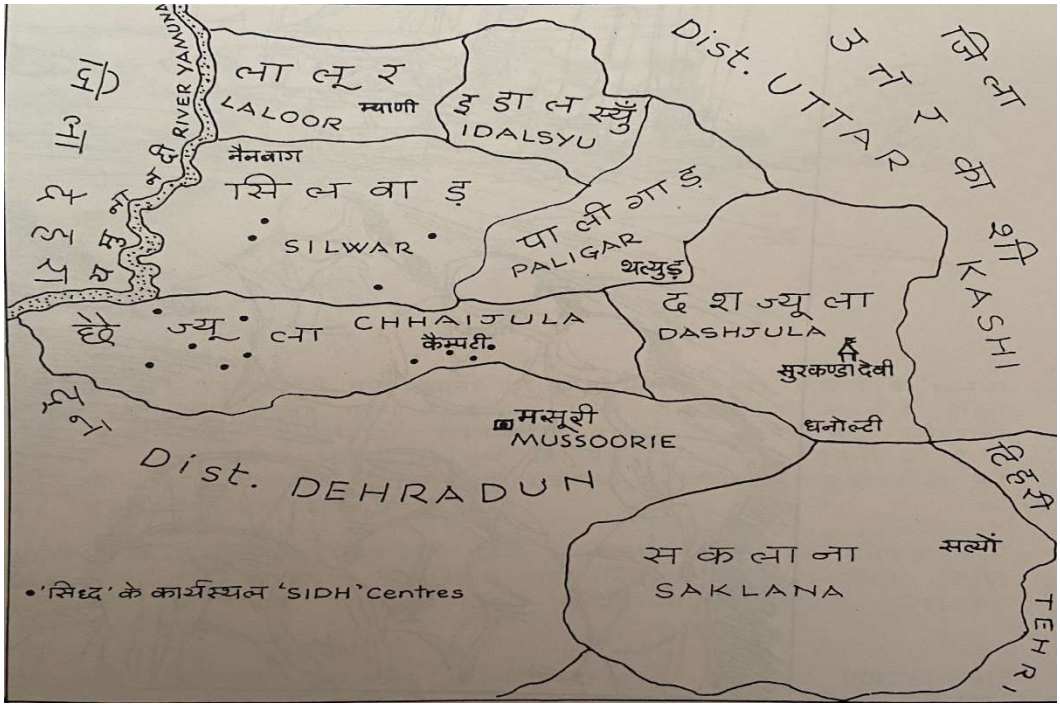


Fig.1.2 ***Map of the Jaunpur region in Tehri Garhwal***

DATA COLLECTION

This study is an attempt by the researcher to explore the Garhwali and Jaunsari communities with regard to their level of understanding of various scientific concepts found embedded in everyday activities. Focused ethnographic methods using non-participant observation techniques and semi-structured interviews were employed for the purpose of data collection, wherein the researcher detachedly observes phenomena without attempting to participate.

The data collection techniques consist of extensive discussion and interviews with villages involved in the selected activities for a period of approximately six months. Detailed interviews of the villagers and children were recorded, supplemented with photographs of concerned data and informants as well. The information gathered in the field from the sample population is of utmost importance as it enables the researcher to capture the perspectives and

interpretations of participants. This facilitates the generation of genuinely novel insights and new understanding.

DATA ANALYSIS

In the present study, the data collected through ethnographic tools like observation and semi-structured interviews are analysed using **thematic analysis technique.** With repetitive schedules of reading and reflecting, overarching themes can be identified through analysis (Strauss and Corbin,1988). The field notes, audio recordings, and interview transcriptions were read again and again, with themes and concepts being identified throughout the process. The underlying narratives were analysed against the following parameters:

- What is the nature of knowledge available in these two communities?

- How does the eco-cultural environment and available artifacts affect the generation of knowledge?

- How is indigenous knowledge transmitted among community members?

- How do community members reason out tacit knowledge?

- Is there any intercommunity communication on indigenous knowledge, and how does such communication influence the tacit nature of community knowledge?

Deciding what to transcribe is important for optimising efforts and explicitly focusing on the research questions and the means required to answer them. This is the reason there will always be more than one way to transcribe spoken discourse; transcriptions reflect the perspectives and goals of its user. In its basic form, transcription technique has two steps: listening to a recording in one's target language, and transcribing them.

Following these principles, the interview transcripts were analysed, with data categorized under various themes. Each thematic category is further analysed to adequately reflect on the notional understanding of scientific ideas and concepts embedded in these cultural activities and how people engage with them. As the purpose of this research is to engage with cultural meanings available in both tacit and dynamic forms, this study is rather explanatory and holistic, as opposed to reductionist and predictive. The researcher was particularly concerned with how concepts and metaphors are used by the Garhwalis and Jaunsaris in their oral narratives. In the absence of written documents to support narratives, one had to completely depend on verbal inputs.

Various cultural artifacts which mediated the knowledge production and learning process of its members were studied. Both the presence and absence of concepts or ideas in different situations were carefully studied so as to gain insight into the belief systems in place within the communities. How prevalent beliefs influence practices and knowledge creation processes was also studied. Analysing the data in the light of the prevalent belief systems is very crucial for a real and deep understanding of the relationship between the underlying cultural and cognitive processes.

TOOLS FOR THE STUDY

A checklist of the topics to be covered during the study was developed for guiding the data collection process. A semi-structured interview was devised to guide researcher during the interview schedule. The interview consisted of questions related to the concepts found embedded frequently in the sample activities i.e. house construction, agricultural tool-making, measuring systems, construction of *gharaat,* etc. The interview also consisted of questions specifically focussing the natives situated in the cultural settings of the Jaunsar and Garhwal. Originally prepared in English, interview questions were then translated into Hindi and the

local dialects during the course of administration. The researcher was assisted by locals who could mediate and interpret local terms which were complex for the researcher.

CHECKLISTS FOR SAMPLE ACTIVITIES

. How do Garhwalis and Jaunsaris decide the direction of the house i.e. whether it should be east-facing, west-facing, and so on?

- . What according to the villagers is the ideal form of house in terms of proper sunlight, air, direction, etc.?
- . How do they decide the total number of doors and windows for houses?
- . What are the considerations in deciding whether to make a single storied or a double storied house?
- . How do they decide the size of the house, numbers of rooms, etc.? Is there any relationship between the number of rooms and family size? After marriage, do children stay with their parents? In case of a conflict, how does the division of property take place?
- . How is the design of a house worked out? Who is involved in the process? Do villagers design houses independently with families, or is somebody from outside the family consulted?
- . When villagers actually construct a house, how do they decide the length, breadth, height, angle etc.? How do they measure them?
- . How do they decide the slope of the roof? What are the ecological and scientific factors that form a basis for this decision?
- . How do they balance the distribution of force on walls? How do they make the choice of construction material? Do they use different types of materials to reinforce different types of structures?

- . How do they decide the number and placement of pillars in a structure so as to have a balanced distribution of force?
- . Do villagers consider the placement of heavier materials at the bottom and lighter materials towards the top of housing structures? What are the reasons behind it?
- . In house construction, who are considered experts and novices? How do experts communicate with novices and others? What is the role of women and children in the construction process?
- If the size of the room is increased, how will they stabilise the structure? (Whether they use beams or divide it angularly etc.)
- . How do villagers develop the understanding for both making and using various tools? Is the concept of force considered while they design their tools?
- . While making tools, how is its shape, size, height, breadth, angle etc. decided? How do villagers measure them?
- . Who makes tools? Are these creators trained people belonging to a specific caste or professional group, or do villagers 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, if any?
- . Has modern technological development impacted villagers in any way? Which modern methods do villagers commonly use and why?
- . How do villagers make design choices so as to make stable housing structures? What are the various ecological factors that shape their decisions?
- . How does the idea of making a stable house influence their decision of making a single/double-storied house?

- . How do villagers decide the size of the house, number of rooms etc.? Is their decision in any way related with the idea of making a stable structure?
- . How do villagers decide the depth of foundation for houses? Is the type of land i.e. rocky terrain, valley terrain, etc. an important consideration?
- What type of foundation do villagers use? (namely, whether it supports all the four walls or are only pillars used to form the base of the support system?)
- . Do villagers have a single roof for entire houses, or do they have separate roofs for each room? If yes, why?
- . How has the occurrence of earthquakes influenced house construction practices? Have villagers shifted to modern construction styles, or do they still rely on traditional methods and why?
- . Does the prevalent culture provide villagers with specific symbols/signifiers to enhance their understanding of the concept of stability/equilibrium?
- . What are the various prototypes available to children in the community to help them understand various scientific concepts embedded in their everyday activities? How are these prototypes made available to children, and by whom?

EFFECT OF CULTURE ON THE SCIENTIFIC PRACTICES OF THE COMMUNITY

- Does language provide assistance to villagers in elaborating conceptual understanding?
- Does culture provide villagers with certain symbols/signifiers which promote their level of understanding of various scientific concepts?
- What are these prototypes available to the child? How are they made available to the child and by whom?

- Does the lack of words in their language hinders their understanding of concepts in any way?
- Does any sort of gender difference exist in the understanding of concepts amongst the Garhwali and Jaunsari villagers?
- How does the prevalent culture define or assign to them what concepts are to be learned, and to what extent?
- What is the effect of formal schooling on the level of conceptual understanding? How does it add on or nullify their culture-specific knowledge base?

CHAPTER-4

RESULT AND DISCUSSION

Each culture creates its own (folk) knowledge. It constructs and expresses these knowledge systems in its material and symbolic resources. Oral narratives are part of this symbolic culture that mediates the intergenerational knowledge dialogues and transfer. Knowledge is never static. It is rather dynamic. Every generation learns cultural knowledge systems while interacting with other forms of knowledge that come from contemporary practices and intercommunity contacts. What constitutes this everyday knowledge is an interaction between so called culturally embedded, artifactually mediated tacit knowledge of the communities and the modern concepts and ideas that travel to these communities through modern institutions like schools and practices. In other words, every community has different forms of knowledge produced through a process of interaction between different tacit and dynamic knowledge forms. This study makes an effort to explore the knowledge systems implicit in the everyday activities of Garhwali community. House construction, agricultural practices etc were selected as sample activities to study the implicit understanding of many scientific concepts. It is assumed that the eco-cultural conditions of villages in Garhwal would be mediating the everyday activities and knowledge systems of its people.

This chapter is divided into four sections. The first section presents the narratives pertaining to the scientific concepts embedded in the traditional house construction practices in the Garhwal region. It also describes the relationship between choice of construction material, ecological conditions and maintenance of room temperature. The second section deals with the functioning of hydro-powered water mill called *gharaat* with the help of narratives provided by the villagers. The third section presents the narratives pertaining to the traditional

agricultural activities in the Garhwal region along with the tools used while farming. The fourth section summarises the analysis.

I. SCIENTIFIC CONCEPTS EMBEDDED IN THE TRADITIONAL HOUSE CONSTRUCTION PRACTICES IN THE GARHWAL REGION

The researcher visited a relatively strong and sturdy 150year old house belonging to a villager named Harshavardhan Chamoli. The owner of the house, a farmer by profession, was a 42 year old man. He was sitting in the compound of his house enjoying hot piping tea with some fellow folks on a bright sunny winter morning doing some random discussions. He gave us a warm hearty welcome and offered tea. When we started talking to him, three of his neighbours also joined in the conversations.

We asked him to talk about how they lay the roofs of their houses and what kind of scientific knowledge they make use of while designing and laying the roofs. Mr. Chamoli said,"…*while making the roof of the house we construct the roof from sides towards the centre. Our houses don't have flat roofs as it rains here. We put beams and wooden frames first and then start laying flat stones from the sides. The assessment of the length, width and the quality of materials is very important for the sturdiness of the structure…..the roof here is unlike the construction pattern followed in flat roofed houses which are made in plain land areas*". Another villager named, Avataar Singh, age 65 years joined the conversation saying, "*The length, width and the slope of the roofs depend on the size of the house, how many beams are used, where these beams are placed etc. Each Dwar or beam is at a minimum distance of at least 1-2 haath.(1* ***haath*** *is equal to some 18 inches approximately). The centre most beam is the most important one as the entire balance of the roof rests on it… therefore, solid wooden*

beams are used for the centre. An important point to keep in mind during the process is that the wooden beams should be in one single piece without any joints in them as they take the load of the roofs on them. If there is no joint, the weight of the roof gets equally distributed over the beam. The length of each beam measures 6ft by 4ft approximately."(किसी मकान की लंबाई और चौड़ाई पर उसकी छत की ढाल तथा चौड़ाई निर्भर करती है। हर द्वार के बीच की दूरी 1-2 हाथ के बराबर होती है।धुरपुला द्वार छत का सबसे महत्वपूर्ण स्थान होता है क्योंकि पूरी छत का भार तथा संतुलन इसी पर निर्भर करताहै।लकड़ी के मोटे मज़बूत लट्ठे इसमें लगाए जाते हैं। द्वार बनाने के लिए केवल साबुत एवं मज़बूत लकड़ी के बीम लिए जाते हैं,उसमें कोई जोड़ नहीं होने चाहिए।इस तरह छत का भार पूरे बीम पर बराबरी से बंट जाता है और उसकी मज़बूती बढ़ जाती है। द्वार की लंबाई तक़रीबन छह फ़ीटसे चार फ़िट के बीच होती है।

Fig 2.1 ***A Traditional Garhwali house with 'Pathal' roof***

As we proceeded with an intense dialogue on the slope of the roof, Mr Jotram pitched in and said,"…… *the angle generally approximates to some 45 degree*." Before the intervention by Jotram , nobody used the term angle. They rather talked about flatness, slopes, beams, starting the roof laying works from the side etc. When Jotram mentioned about angle, we became curious about how he explains the roof laying process vis-à-vis others. We asked him why 45 degree and not more or less.

Jotram explained, "*60-70 degree slope is required in areas situated at much higher altitude as they got heavy snowfall. We generally find them in Himachal Pradesh. In order to allow the snow to move down freely and conveniently such steep slopes are required in those regions. But in Uttarakhand the main concern is heavy rainfall, not snow. We therefore maintain an angle of roughly 45 degrees at the centre*." (60-70 डिग्री की ढलानदार छत की ज़रूरत बहुत ऊँचाई वाले स्थानों के लिए होती है, जहाँ ज़्यादा बर्फ़ गिरती है जैसे की हिमाचलप्रदेश।बरफ़ को आसानी से नीचे गिराने के लिए इतने ज़्यादा ढाल की ज़रूरत पड़ती है। पर उत्तराखंड में मुख्य समस्या तेजबारिश की है ना कि बर्फ़बारी की ।इसलिए 45 डिग्री की ढलान वाली छत हमारे इलाक़े के लिए बढ़िया होती है।)

Interestingly, Mr. Jotram a mason (*mistri*) by profession was working in both hilly and plain areas, replied using his own practical knowledge of the practice. While others used the expressions, "*starting from the sides*" and the quality, numbers and position of beams, Mr. Jotram used the term angle for the first time. While others differentiated houses between plain areas and hilly areas, they used the term flatness and slope whereas Mr. Jotram used the term angle along with other terms. Even though the central concepts of their roof laying narratives was different (slope and side for the villagers and angle for Mr. Jotram), there doesn't seem to

be any communication loss between them. The mutual intelligibility was high even on the scientific ideas.

It is here that we noticed how these three villagers talk about a stable roof using two different kinds of imaginaries and they both know that they talk about the same thing almost equally effectively. One organises his imaginary around slopes and sides, while the other one organises around area/shape and angle. This was clear when they start to talk about measurement part where they used the terms *haath* (hand's length) and *suut* (thread) as measuring units.

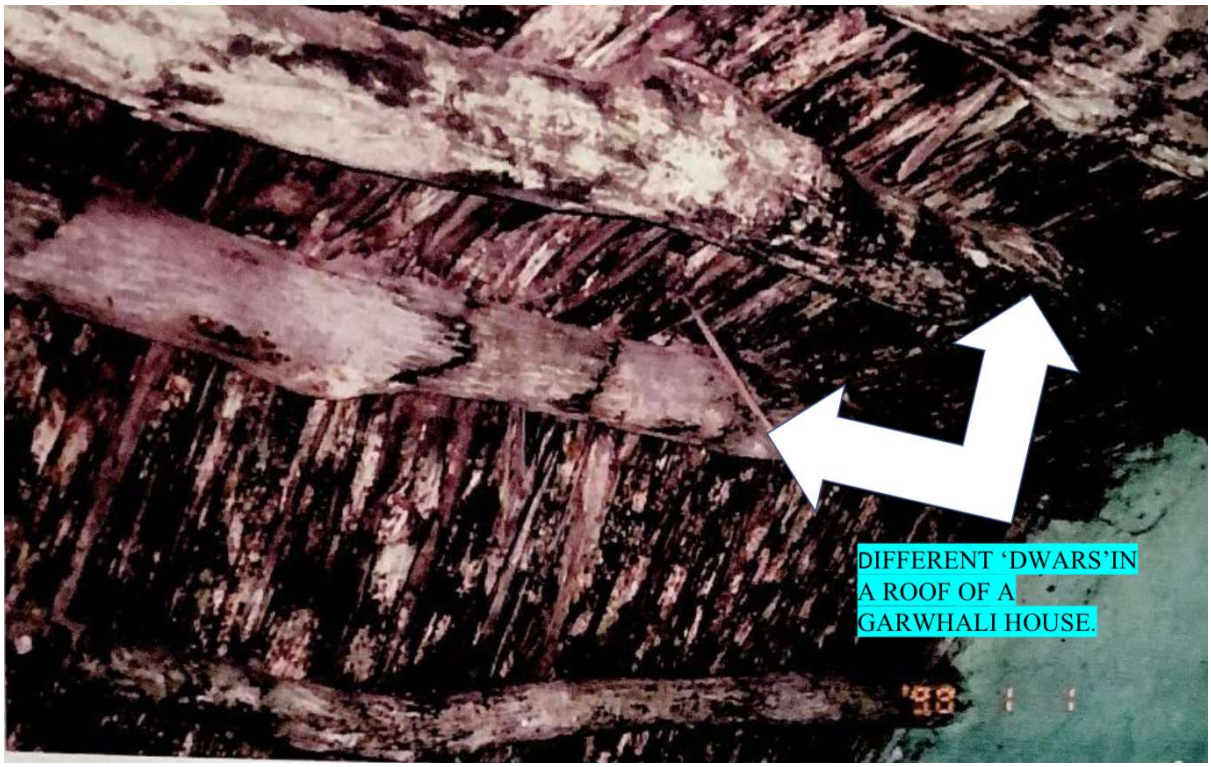


Fig 2.2 ***Inner view of roof of a Garhwali house***

Mr. Jotram moved temporarily between old and the recent times using different measuring units , "*Since olden times, we use our indigenous ways of measuring slope in terms of haath or hand. From the centre beam of the roof (dhurpula dwar) towards the sideways reaching the door or the outer beam, the length of the roof slope on each side generally measures between*

4-4.5 hands/haath. Now-a-days, we work more with angles. The size of the angle is generally decided using floor area, the size, height and position of the beams. We also use fixed length thread (suut) for measurement of length". (पुराने समय से ही हमारे यहाँ छत की ढाल हाथ से नापा करते थे ।धुरपुला द्वार से किनारे की तरफ़ जाते हुए छत की ढाल दोनों तरफ़ चार से साढ़े चार हाथ के बराबर होती थी।आज कल सब लोग एंगल में बात करते हैं पर पहले हाथ और सूत का इस्तेमाल कर के एक बढ़िया छत एवं मकान मनाया जाता था।मकान की लंबाई, चौड़ाई एवं लकड़ी के लट्ठों के ऊपर निर्भर करता था कि उसकी छत की ढलान कितनी होगी।)

Mr. Chamoli explained, "…*during roof construction, we start side wards from the beams above and near the doors (dwars) first and gradually move towards the centre. To check if all the dwars (doors) are in alignment with each other, we take the help of suut or thread to measure the length of the roofs on both the sides of the central beam in order to make them equal. If the lengths are identical, we know that the roof is stable. We don't measure the angle, but we know that if both the sides are equal, the angle is right." Upon asking about the use of angle, Mr. Chamoli said that "We don't start with angle nor we measure the angle at the centre beam. If there is any problem of balancing the roof, we adjust the angle a bit. But, the adjustments are generally minor. If a bigger adjustment is required to make the roof stable, we lay the roof once again using our principles of length of the roof sides, beams and the ecology".* (छत डालते वक़्त हम किनारों से बीच की तरफ़ बिछाते हैं यह पहचान करने के लिए की छत मज़बूत और सीधी है सूत अथवा धागे काप्रयोग किया जाता है ।धुरपुला द्वार के दोनों तरफ़ की लंबाई मापने पर अगर बराबर हो तो इसका मतलब छत मज़बूत है और सही बनरही है।हम कोण का प्रयोग नहीं करते पर अगर धुरपुला द्वारके दोनों तरफ़ की छत बराबर है तो छत की

ढलान सही है।थोड़ी समस्या होने पर हम ख़ुद ही अंदाज़े से छत का कोण ठीक कर लेते हैं।पर अगर समस्या ज़्यादा हो तो छत दोबारा डाली जाती है क्योंकि मज़बूती के लिए छत के किनारों की लंबाई ,लकड़ी की मोटाई और आस पास के वातावरण का ध्यान रखना बहुत ज़रूरी है ।)

Fig 2.3 ***Dwars in a traditional Garhwali house***

Based on their everyday experiences and knowledge of house designs in the region, the villagers were convinced that the slope or slant of roof of the house should be relatively less as it drains out rain water easily while remaining cost effective and easy to manage the weight of the roof on the walls. Mr. Chamoli mentioned about the hilly topography and said, "...*since the tall houses will exert more load on the ground, in hilly areas we avoid erecting tall houses.*

As the people are of short stature, we don't have the need for a tall room." (पहाड़ी लोग बहुत लंबे चौड़े नहीं होते और उनकी क़द काठी भी मध्यम होती है इसलिए बहुत ऊँचे घर बनाने की आवश्यकता नहीं होतीहै।घर की ऊँचाई बढ़ाने के लिए हमें और भी बहुत सी बातों का ध्यान रखना पड़ेगा जैसे कि छत भी बड़ी होगी ,ज़्यादा संसाधन चाहिए होंगे .....इसलिए हम यहाँ पहाड़ में बहुत ऊँचे और लंबे घर नहीं बनाते हैं।)

The villagers generally did not use the term angle (*koand*) while explaining the roof construction process in the region except the mason who was also working in the plain areas. They exhibited a good ecological understanding of the region and were not willing to make big and tall houses that might disturb the land structure of the area. They trusted their local masons on these decisions. Ramesh Kumar, another farmer from the village said, "*There is no specific instrument to measure the slope or the angle while making the roof of the house. We depend on the mistri or the mason completely as we believe that the local masons know their job the best. They know how much slope to keep or not to keep*". (घर की छत बनाते वक़्त हमारे पास कोई ख़ास औज़ार नहीं होता जिसे हम उसकी ढाल को माप सके।पूरी तरह से इस काम के लिए हममिस्त्री पर निर्भर होते हैं क्योंकि हमारा विश्वास है कि वो अपना काम बहुत अच्छी तरह से जानते हैं और उन्हें पता है कि छत में कितनीढलान होनी चाहिए ।

The mason would use the hand as a measurement device for the same and keep the length of each side of the roof roughly at 4-4.5 hands (each hand roughly measuring 18 inches) maximum for a small house and 7-7.5 hands for a relatively larger house. They used the idea

of right angle while laying the walls. For this, they used an indigenously manufactured tool called ***'gundiya'***. It is made up of wood or iron. In recent time, people purchase it from the local market. But earlier the masons used to make it themselves. They used to take a round piece of wood and divide that into 4 equal parts from the centre. Each piece was used to make a '***gundiya***'. (Ref Fig 1.4 and Fig 1.5)

Another mason named Ramesh was standing close by and was listening to our conversations. He intervened at this stage and narrated his version of making '***gundiya***'

."*To prepare '**gundiya**'. we take a round piece of wood and divide it from the centre. ....From that line, we put two arcs or 'koand' (in local language) on the periphery of the round wooden piece and then draw a line from that very point. A wooden piece with a 90 degree angle is created this way.....*

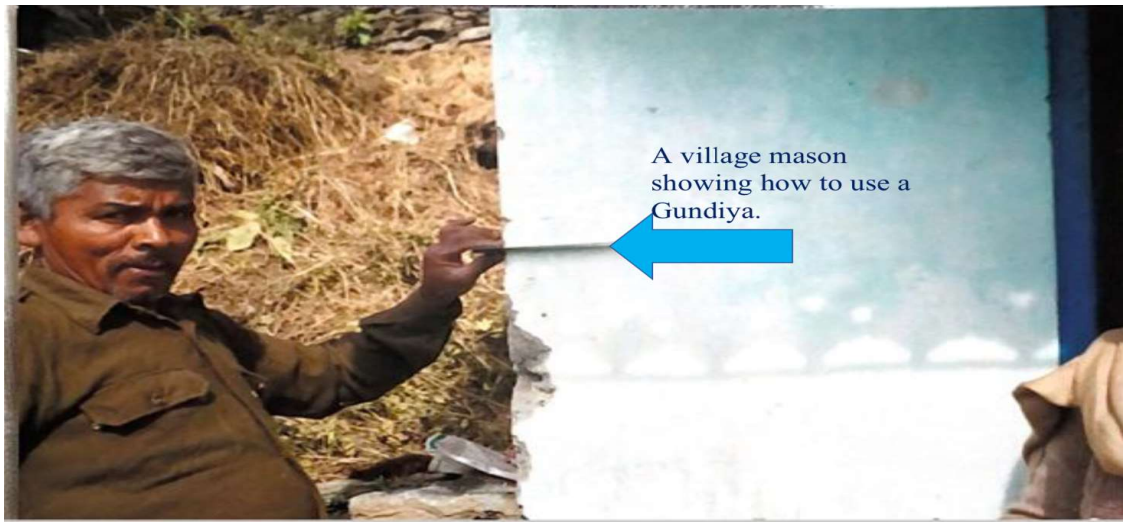


Fig 2.4 ***A village mason showing how to use Gundiya***

Fig 2.5 ***A Metal Gundiya***

Mr Muyal, another mason from the village said," …..W*hile constructing houses in this region, we make use of a string or thread to measure the diagonal distance between two consecutive walls. If distances between two diagonals in a rectangular or square room are equal, we know that the roof is proportionately laid. Otherwise, the weight of the roof will not be distributed equally over the walls and the beams*".(पहाड़ी इलाकों में मकान बनाते समय दीवारों की सीधाई मापने के सूत का प्रयोग करते हैं । किसी चौकोर वृत्ताकार कमरे को बीच सेकाटते हुए दीवार के एक कोने से दूसरा कोना मिलाते हैं। अगर दोनों की लंबाई बराबर हो तो इसका मतलब कि दीवारें सीधी बन रही हैंऔर छत भी बराबर डली है।ऐसा न होने पर छत का भार चारों दीवारों पर बराबरी से नहीं बटेगा और मकान कमज़ोर बनेगा।)

Interestingly, what the modern masons achieved by measuring angle and working through angle, the local masons achieved by working through the comparative length of the diagonals

of the rectangular room and the length/width of the roof sides. Both seemed to have implicit understanding of Pythagorean principles in terms of areas and their relationship with weight and stability.

Mr. Muyal said, “Additionally, we measure the distance of the two walls facing each other. If both the walls are equidistant from the centre, we know that the two sides of the roof will be of similar size as well as slope from the centre. While building the sloped roof houses, the garhwali villagers decide the length of the house as per their requirements and fix the height of the centre of the roof, called *dhurpula dwar* accordingly. Additionally, they consider the gradient of the land on which they construct the house and the soil condition of the ground. They use this information to decide the size of the wooden beams that support the roof. They calculate the area of the roof using their hands that needs to be covered by *pathaals.*

A thread or *‘’suut’* is generally used to measure the length, width and height of the house. Thread is the most easily available and commonly used means to measure the accuracy of length, height and width. They also used an instrument called ***‘guundiya’*** made of wood/metal and is either made by the *mistri* himself or bought from the local market. Earlier, *‘guundiya’ was always made by the mason himself. It is an ‘L’ shaped instrument used to make sure the walls are standing straight on the ground. The villagers generally didn’t use the term angle, they rather used the term ‘koandd’ which means slope or dhaal. koandd, according to them refers mostly to the slope/dhaal of the roof.*

The use of the measuring instruments like ‘*suut’* and **‘***guundiya’* and concepts like *koandd/dhaal* for assessing the accuracy and strength of the roofs further confirms our finding that while modern masons work with angle, the local masons work with side lengths, diagonals and slope so far laying a stable roof is concerned. At notional level, the villagers had understood the relationship between height, length and width in the context of areas and weight. The

villagers are not using it in referring to angle in scientific or mathematical terms. Rather it is used to describe the accuracy of the walls. They also had ideas of how to distribute the vertical force over beams/wall in a manner that the roof becomes stable and doesn't create cracks either in itself or in the walls. The villagers were also sensitive to the soil conditions and how much weight the soil in an area can take.

We became curious to find out how the villagers ensure the accuracy of the '*gundiyaa*' and asked about it. Muyal replied in a confident tone using the term, 90 degree, "Whenever we divide the circle into four equal parts, each piece become an angular one and the angle is always of 90 degrees."(जब भी हम किसी भी गोलाकार लकड़ी के टुकड़े को चार भागों में विभाजित करते हैं तो उसका हर भाग आयताकार होता है और सबभाग में 90 degree का आयत होता है।)

Upon further enquiry, we found that his knowledge of how to create accurate *'guundiya'* is not acquired from formal schools but from practice sessions where he learnt from errors. He learnt many of these from senior adults, friends and neighbours in the village. When we asked about his knowledge of angles, say 90 degrees in this context, he said he had picked it up from other masons working in the plain areas and now has some working knowledge of how to ensure that the walls of the house stand straight at right angle from the ground.

Another old man started describing how these knowledge systems are not formally written down in books. These are transferred across generations through observation, informal instructions and working together on house construction. The above mentioned two different discourses on the making of one single instrument reflects the same thought vividly. The everyday or the local knowledge system finds its base in the age-old practices which have been

put into practice after a thorough understanding of the ecosystem as well as the available resources in this area.

The villagers do not prefer very long houses in the region and their houses have an approximate length of about 10 feet by 10 feet with a single central beam and roof. They divide the inside of the house into 2-3 small rooms as per the requirement using mud and wood walls. According to the villagers, long houses are not preferred primarily because of the difficulty they may face in balancing the heavy *pathaals* in a big area. As narrated by Mr. Ramesh Chandra, "Since wooden planks have to be used in the roof and they have an approximate length of roughly 10-11 feet, we try and keep the length of our houses close to this length. We do not make any pillars inside the room to support the roof. The entire force of the roof rests on all the four walls of the house. We use mud walls to create smaller rooms after the roof is laid. (मकान बनाने के लिए चीड़,डैंगड,तून आदि की लकड़ी मज़बूत मानी जाती है जिसे जंगल से लाना पड़ता ।पेड़ के लट्ठों के स्वाभाविकलंबाई पर हमारे मकान की लंबाई निर्भर करती है जिसे हम ज़्यादातर 10-11 फ़ुट रखते हैं।हमारे मकान की छत का पूरा भार चारोंदीवारों पर होता है क्योंकि घर के अंदर और कोई सहारा छत को नहीं दिया जाता।घर के अंदर मिट्टी की छोटी दीवार बनाकर हम अपनीज़रूरत के अनुसार कमरे बना लेते हैं ।)

The construction of house in Uttarakhand region is a time- consuming process and usually involves the entire village. It is a community level activity and everybody tries to help in undertaking different activities related to house construction. Nobody is paid for the work except that the house owner takes care of food during the entire process of house construction.

In local language, it is said that,"हमारे यहाँ पहाड़ में कहते हैं कि एक पीढ़ी मकान बनाती है और अगली कई पीढ़ियां उसको भोगती है ।मतलब मकान बनाना बहुत मेहनत वाला और जटिल काम है। इसलिए हम ध्यान रखते हैं कि वह ख़ूब ठोस और मज़बूत बने ताकि आने वाले कई सालों तक मौसम के थपेड़े सहकर टिका रहे ।" (It takes an entire generation to build a house and the coming generations sit back and enjoy it Since olden days, people want to make their house as strong as possible so that it can withstand the vagaries of nature and still stand strong).

When constructing a house, they start from the foundation, which is generally 2.5-3 feet deep. While digging the ground, they stop when they get '*pakki zameen*' (bed rock). *Pakki Zameen r*efers to the point where one hits or finds big stones under the ground. Once the foundation is laid, the walls are built with the help of big stones. Small pebbles are used to fill in the gaps between the big stones. The walls of the houses are generally broad. In earlier times, people used to have even 22-24 inches or 2 feet broad walls.

As described by Mr Harshvardhan Chamoli, "In older times, people used to have broader walls in their houses. You can see my own house (Ref Fig.1.6). 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 older days, people wanted to make their houses very strong and according to them, more is the breadth, stronger is the house. But now you see, young people do not have that much patience to spend a year building a single house. Also because of large-scale migration of youth from the villages due to unemployment, we lack the required labour force to carry heavy logs of wood and other construction materials."(पुराने समय से ही यहाँ पहाड़ों में लोग दो दो फ़ीट की बहुत चौड़ी दीवारें बनाते हैं।हमारा ही मकान देखो.....हमारा मकान लगभग डेढ़

सौसाल पुराना है जोकि पुरखों के समय से चला रहा है।हमारे घर में भी 2 फ़ीट मोटी दीवार है पर आज कल लोगों ने दीवार की चौड़ाईकम कर दी है।एक तो आज कल के लोगों में धैर्य नहीं है ।गाँव के जवान लोग रोज़गार के लिए पलायन कर गए हैं। भारी लट्ठे औरपठाल पहाड़ों से लाने के लिए उनकी ज़रूरत होती है।इसलिए हमको अपना मकान बनाने की प्रक्रिया बदलनी पड़ी।)

Fig 2.6 ***A traditional Garhwali house with 'Satir' and 'Tibaari'***

The researcher visited the house of another villager for an in -depth enquiry about their house construction practices. Mr Ramesh Kumar who was the owner of the house gave a warm welcome. After initial conversations, the researcher asked him about how they measure if the two walls of the house are equal in length or not?

Mr Kumar smiled and replied," *Villagers depend entirely on the understanding of the mason (mistri) for the construction of their houses. We believe that the mistri is God gifted and therefore he can make accurate walls and other structures."* He however talked about measuring *lambaii (*length***)** using arm length (*haath)* and long thread.

DISTRIBUTION OF PRESSURE IN THE TRADITIONAL HOUSE CONSTRUCTION PATTERN

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 multiple factors. In case of bigger roof, the villagers use wooden pillars (***sahwan*)** that helps in distributing the vertical force into horizontal ones. The villagers generally used weight (*bhaar)* or pressure (*jor)* for force. One villager, Mr Rajendra Prasad Kala, talked about the importance of putting extended supports in a house.

"*.....The **sahwan** is made of wood pieces that are half buried inside the upper wall. These **sahwans** make the walls strong enough to bear the pressure of the roof.....these sahwaan support the pathaals as well as dwars to stay on in their places.....while constructing the roof, the stone slabs are not plastered. They are just placed accurately at the right place and allowed to stand there. Owing to their heavy weight, they do not get displaced easily and withstand normal weather conditions. **Sahwaan** extends an additional support to the roof slope and prevents the pathaals from falling."* (सहवान लकड़ी के लट्ठे होते हैं जो की ढाल वाली छत को एक मजबूत सहारा देते हैं ताकि पठाल नीचे सरक ना जाए।ये आधे दीवार केअंदर गढ़े होते हैं इसलिए इनकी मज़बूती घर की छत का भार उठाने के लिये पर्याप्त होती है। छत पर लगाए जाने वाले पत्थर की स्लेटया पठाल किसी प्लास्टर से नहीं चिपकाए जाते हैं अपितु इनको बस

सही जगह पर मज़बूती से रख दिया जाता है और साथ ही मिट्टीऔर घास की परत बिछा दी जाती है।अपने भारी वज़न के कारण पठाल अपनी जगह पर स्थिर रहते हैं और भौगोलिक परिस्थितियों कासामना मज़बूती से करने के लिए सक्षम होते हैं।

Placing the ***sahwan*** skill fully between the roof and the vertical walls indicates towards the evolved knowledge of size, weight, force and balance within the community. The villagers share implicit knowledge of how to prevent the entire vertical force of the roof falling on the walls alone, thus making it liable to break.

The villagers first construct two walls and then lay the front and the back walls. The front and back walls are constructed covering the height of the doors. A series of wooden beams called ***sahwans*** are put horizontally on the walls that expand the base of support to roofs. These ***'sahwans'*** or horizontal beams form the primary base for laying of the roof.

The villagers do not put the entire pressure of the roof on the walls including ***sahwans***. Rather, they use horizontally laid *dwars* (Ref. Fig. no.1.3, Pg.7) to distribute the load of the roof equally at different points on the four walls of the house.

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 the train. The pressure exerted by a running train is massive 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.

The house belonging to a villager named Mr Ramesh Chandra had a *'tibaari'*, which has uncovered extensions to the balcony/verandah. We enquired him regarding the support below the extensions seen at regular intervals and also beneath the '*tibaari*' in the house.

'tibaari' is the living room or drawing room found in some of the houses in Garhwal region. It is usually found in houses of people with a good income and is representative of the financial status of the owner. Each *tibaari* has 3-5 pillars made of stone. The distance between the two pillars is 2 *haath* or 2-2.5 [1] feet. The *tibaari* gets the structural support from extensions made of stone slabs called '*satir.*'

***"Satir** are support made of stone slab and put inside the wall so that it covers the entire thickness of the wall and the other half of the stone slab which is protruded outside acts as a support to the tibaari.(chajja or nimdaari-local term used for it)...."* (पहाड़ी मकानों में एक बरामदा या बैठक देखने को मिलती है जिसे अलग अलगनामों से पुकारा जाता है जैसे की तिबारी , नीमदारी इत्यादि।आम तौर पर एकतिबारी 15 फ़ीट लंबी तक होती है जिसमें आमतौर पर छह खंबे तक होते हैं ।पत्थर के भार को दीवार पर बराबरी से बाँटने के लिए मिस्त्री इसमें पत्थर के लाट या स्लैब लगाते हैं।पत्थर के यह स्लैब आधे दीवार के अंदर होते हैं और आधेबाहर। बाहर वाला हिस्सा तिबारी को पर्याप्त मज़बूती प्रदान करता है ।)

Here the vertical force of the balcony is shared by the stone supports, which convert it into a horizontal force, thus making the tibaari /*nimdaari* more strong and stable . The exact local term for these stone extensions was provided by another villager, Mr Harshapati Juyal. He told, "*These are called **'Satir'*** (see Fig 2.7) *and the breadth of a **satir** is double to that of a wall in these houses because half of it is buried inside the wall and the other half stays outside."*(इनको यहाँ की प्रचलित भाषा में सतीर कहते हैं।यहाँ पे प्रचलित प्रथा है कि कोई

भी चीज़ जितनी मोटी एवं चौड़ी होगी ,उतनी हीमज़बूत होगी ।इसीलिए हम लोग सतीर की मोटाई को दीवार की मोटाई से दोगुना रखते हैं। मतलब यदि दो फ़ीट की दीवार है तो चारफ़ीट का सतीर होगा ।ऐसा इसलिए क्योंकि सतीर का आधा हिस्सा दीवार के अंदर रहता है और आधा हिस्सा बाहर होता है जोकि घरकी छत को और मज़बूती प्रदान करता है।)

Fig 2.7 ***Showing 'Satir' in a Garhwali house***

- *Fig 2.8* **Picture depicting the distribution of roof pressure on the four walls**

The researcher spoke at length to a number of villagers and found that the cross-sectional beams running across the room in these village houses helps to convert the large amount of vertical force into horizontal force and also distribute it uniformly between all the four walls so that the entire force does not fall on a single unit. This provides more stability, strength and longevity to the house. Primarily because of this many houses in the region were able to withstand the vagaries of nature in the form of massive earthquakes from time to time.

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

The prevalent ecological conditions in the region force the villagers to keep the heights of their houses at low levels. As the village is in an extremely cold region of the state, people constructed low roofed small houses, so that the houses are keep warm and comfortable in winters. Mr Kala said:

"*less number of doors and windows are found in the houses in the hills because more is the number, difficult it is to maintain warmth inside the house in extreme cold conditions. The pathaals are used for laying roof as they 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 cost of procuring pathaals from far off places is very much. Most of the youth has migrated in search of work so we have to hire labour for the same. Otherwise who would like to let go of a system which proved so efficient in the prevailing eco cultural conditions….*"(पहाड़ी घरों में दरवाज़े और खिड़कियाँ कम संख्या में बनाए जाते हैं क्योंकि ज़्यादा संख्या होने पर घर के अंदर गर्माहट नहीं रहती है ।पठाल की बनी छत घर के अंदर का तापमान बनाए रखती हैं। पठाल के बने घर गर्मियों में ठंडे और सर्दियों मे गरम होते हैं ।आज कलकी परिस्थिति अनुसार हम टीन शीट की छतें बनाने लगे हैं ।हमारे पारंपरिक तरीक़े यहाँ की भौगोलिक परिस्थितियों के लिए सर्वोत्तम हैं।वो बात इन आधुनिक चीज़ों में नहीं।)

The villagers had deep knowledge of the stone not being a good conductor of heat. They seemed to have a notional understanding of thermal conductivity of dense materials, passive cooling and thermal lag. Mr. Kala talked about some of these ideas:

"*The stones and pathaals take a longer time to get warm and also take a similarly longer time to cool. In winter, the heat inside the house stays longer because of the dense stone walls and pathaals. Since we cook inside the house, in winter that also helps to maintain the room temperature. Similarly, in summer, these stones and pathaals protect the rooms from the extreme heat of the sun*".

पठाल एवं पत्थर दोनों गरम होने में लंबा समय लेते हैं तथा उसी प्रकार ठंडा होने में भी उन्हें काफ़ी समय लगता है। सर्दी के मौसम मेंपहाड के मकान लंबे समय तक अंदर से गरम रह पाते हैं क्योंकि उनका तापमान पठाल की भारी छतों तथा पत्थर की मोटी दीवारों सेसंतुलित रहता है।घर के अंदर बना रसोईघर भी वातावरण को आरामदायक रखता है।उसी प्रकार गर्मियों में सूर्य की तेज किरणों से घरोंको सुरक्षित रखने में पठाल सहायक होते हैं।)

When we enquired with a school teacher about the scientific ideas behind Mr. Kala's narrative, he told: "*...the villagers have the understanding of how to maintain the temperature inside the house. They understand the nature of the local materials in terms of conductivity well and apply this knowledge in house construction. According to modern science, dense materials such as stones and earth have a number of properties that allow them to act as good insulation from heat. These include good thermal conductivity. In other words, these stones and other heavy earth materials have the ability to release passive cooling. They have thermal lag and transmit heat slowly. They also have low reflectivity and therefore have lower*

redistribution of heat. The pathaals and stones used by the villagers specially have high volumetric heat capacity (elevated ability to store heat) when used in bulk."

Likewise the villagers in this village explained the importance of ***pathaals*** or stone slabs in the lives of the villager. Mr Kala gave a detailed narration with this regard which is quoted as follows:

"The stone slabs or ***pathaals*** are extracted from the mines situated high up in the hills. From a big rock, numerous ***pathaals*** can be extracted.....The rock has multiple natural layers in it which can be seen as very fine lines on it .The villagers separate the slabs from the main rock by striking on these lines with a chisel and hammer .The slabs are then carried to the construction site and used to make roof of their houses."(पत्थर के स्लैब या पठाल,जैसा कि हम पहाड़ में उन्हें पुकारते हैं, उनको ऊँचे ऊँचे पहाड़ों,डांडों से लाना पड़ताहै।एक बड़े पहाड़ सेअनगिनत पठाल निकाले जा सकते हैं। पहाड़ में प्राकृतिक रूप से बनी परतें होती हैं जिन्हें रेखाओं के रूप में देखा जा सकता है। लाइनोंपर हथौड़ी और छेनी से वार करके गाँव वाले पठाल को अलग करते हैं। उसके बाद ये पठाल गाँव में मकान बनाने की जगह पर ले जाएजाते हैं और मकान बनाने हेतु उन्हें प्रयोग में लाया जाता है।)

A villager Mr Dinesh Chandra Rodola 45 years old also had a house with a roof made of ***pathaals***. We asked him why they feel that ***pathaal*** roofs are better for the region. He replied that:

"....look child, stones are so strong and thick that they do not allow anything to pass through it. As the ***pathaals*** 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 these climatic conditions....so eventually even we have adopted it." (यहाँ गढ़वाल में पहाड़ बहुत ऊँचे, विशाल और मज़बूत होते हैं।पठाल भी इन्हीं पहाड़ों से निकलते हैं इसलिए वे भी बहुत मज़बूत होते हैं।हवा, धूप आदि कुछ भी इनसे आर पार नहीं हो पाता है। हमारे पुरखे इसी प्रकार से घर बनाकर सदियों से रहते आए हैं ।इस प्रकार के घर हमारी भौगोलिक परिस्थितियों के लिए उत्तम है इसलिए हमने भी इस पद्धति को अपना लिया है।)

There are three methods by which the transmission of heat takes place and conduction is one of those methods. In Conduction, heat enters from 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, glass are bad conductors (good insulators) of heat. The villagers had adequate knowledge of these materials being bad conductors of heat even if they didn't use the term "bad conductors" or "good conductors". They rather talked about these phenomena using the expressions heat holding or releasing capacity.

These villagers' everyday understanding of heat conductivity can be compared to that of Eskimos' understanding of how to use local materials for building houses in cold regions. Eskimos have deep knowledge of the thermal conductivity of ice being low. An igloo works by not allowing the heat generated by the inhabitants from escaping the house into the surroundings. Thick snow walls of the igloos keep the temperature inside of the house high, even when the temperature outside is extremely low. The ice and the still air both acts as highly effective insulators. (Britannica, The Editors of Encyclopaedia." igloo". Encyclopaedia Britannica,2008).

The villagers use everyday language to give multiple reasons for using *pathaals* e.g. easy availability, durability, and conduciveness for the climatic conditions. Bricks are porous

and therefore continuous rainfall in this region would cause acute dampness in the house. Damp houses are usually cold, making the conditions worse in chilly winter months. ***Pathaals*** on the other hand 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 ***pathaals*** helps a lot in keeping the house dry, safe and comfortable. The most important concern in a ***pathaal*** roof is accuracy in maintaining a slope while laying of the ***pathaals.*** The pattern of laying a ***pathaal*** roof was explicitly explained by another villager, Mr Harshapati Juyal:

"*.....here in the village or rather in the entire hilly areas of Uttarakhand, we invariably construct the roof from below and then move upwards to the centre top. In every step, the* ***pathaal*** *placed below is covered by the one above it. The crevices between two* ***pathaals*** *are thus covered and this helps in preventing seepage of water inside the house...When the centre is reached, we seal it properly with the help of small stones and mud so that it is nicely packed and cover that with* ***pathaals****. This is the point where the balance of the force of the entire roof lies. It is known as the 'Dhurpula Dwar (see fig 1.9).' Whenever we repair the roof, we start unwinding it from the top central part, i.e. Dhurpula Dwar*." (जब हम नीचे से ऊपर की ओर पठाल बिछाते हैं तो दो पठालों के बीच के अंतर को भली प्रकार से एक लेप से बंद किया जाता है या भराजाता है ।छोटे पत्थर ,मिट्टी और गोबर से एक लेप तैयार कर हम उन अंतर को अच्छे से भर देते हैं। पूरी छत का सारा भार इस जगहपर केंद्रित होता है इसलिए इसकी मज़बूती बहुत ज़रूरी है ।छत की मरम्मत के समय भी हम उसको धुरपुला द्वार से ही खोलना शुरूकरते हैं ।)

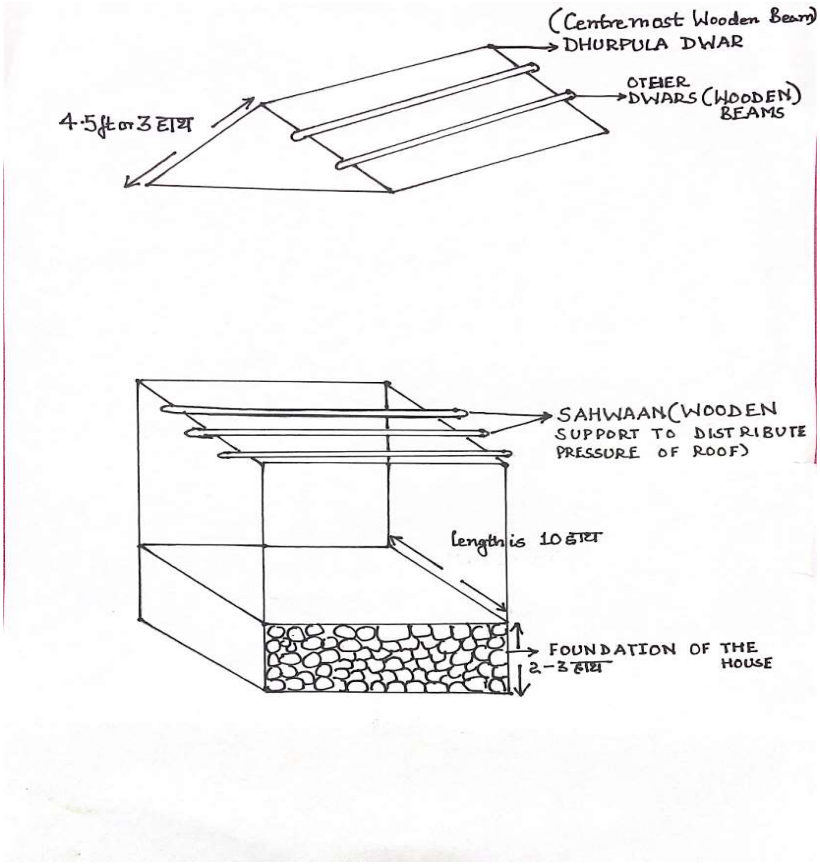


Fig 2.9 ***Cross sectional view of a Garhwali house***

A narrative provided by another villager, Mr Ramesh Chandra further elaborates the systematic idea embedded in this action:

"*Whenever we make the roof of the house, we start putting* ***Pathaals*** *from below/sideward and slowly move towards the centre. See(demonstrates)...in this manner, the* ***pathaals*** *are stacked one on the top of the other in a manner that it drains water down quickly.....because of this roof design, the water flows down completely without getting into the rooms. The Dhurpula which is the lifeline of this roof provides stability and makes the roof stronger....*"(मकान की छत बनाते वक़्त हम पठाल नीचे से ऊपर की तरफ़ बिछाते हैं।इस प्रकार ऊपर वाला पठाल नीचे वाले पठाल पर दबाव बनाताहै और उसे मज़बूती के साथ अपने स्थान पर बिठाए रखता है। इस कारण ऊपर से बहता हुआ बारिश का पानी सीधा नीचे चला

जाता हैऔर उसे घर के अंदर जाने का कोई रास्ता नहीं मिलता है। किसी भी पहाड़ी घर की छत में धूर्पुला, उसकी जीवन रेखा होती है क्योंकिउसकी मज़बूती से ही मकान की छत और मज़बूत और टिकाऊ बनती है।)

Hilly areas in Garhwal region mostly face the problem of extreme cold climatic conditions and the usage of *pathaal* and wood in house construction safeguards the natives from the vagaries of nature. The villagers had extensive practical knowledge of the local materials. They knew that the stones and wood keep the houses cool in summer because stones are good conductor of heat. The stones conduct heat inside the room away quickly. Besides this, whatever heat it conducts from the sun, is prevented from entering the house fully by the wooden beams used in the roof. Wood being a bad conductor of heat conducts heat only from the surface it touches. Hence only a very small amount of heat is conducted inside the room. Stone which is used in making the walls of the house helps in conducting it away. A balance is maintained with the use of wood and stone which keeps in maintaining the temperature inside the house.

DISCUSSION

The analysis reveals the presence of scientific ideas embedded in the house construction practices in the Garhwali community. 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 help them to efficiently adapt to their surroundings. These practices are based on the culturally transmitted indigenous knowledge of the natives, which aims at increased sustainability within 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. The researcher started with the roof construction of the house. They use deodar logs or beams for the purpose owing to the long life and strength of the wood. In the harsh terrains of Uttarakhand, the main desire of the villager is to achieve the locally earmarked benchmark of doing the mundane activities in order to sustain in their surroundings. They strictly abide by the advice of the community elders. Most of them do not really have explicit logic or explanation for their actions. They have witnessed the reliability of these tools and methods over a period of time in their environment and hence depend on them fully.

One of the villagers, Mr Harshpati Juyal explained about their idea of force. Their main aim is to keep the *bhaar* of the roof on the walls of the house as little as possible. They use stone slabs or *pathals* in the construction of roofs, which are very heavy and this automatically increases the roof load. Therefore the villagers use extended supports of wood or stone called **'*satir*'**. These supports help to convert the vertical force of the roof into horizontal one thus sparing the wall from bearing the entire load of the roof.

When we try to probe the community for its understanding of this concept, we got mixed reactions. The elders spoke about it vaguely, as '*siddhai'* or '*bhaar*' of the object. For them it is very essential to maintain the proportion of length and breadth of a building so that it remains erect. Several anecdotes mention how villagers are punctual about making their houses in a specific traditional way. In the entire conversation none of the villagers used the term 'force' and instead referred to it as *bhaar* or load. But this 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. Gradient of the land and the condition of the soil both help in deciding the size of the wooden beams /*dwars* that are put across the room to support the roof.

Mr Muyal 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 the distance between two 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. Both local and modern masons seemed to have implicit understanding of Pythagorean principles in terms of area and their relationship with weight and stability.

The use of *pathals* by the villagers in the house construction process is indicative of their folk wisdom. As per the narrations of the villagers, the *pathals* help in keeping their houses warm during winter and cool in summer season. Though they could not explain the process using scientific terms, yet their choice of it as a construction material reflects a lot about their rich local knowledge system.

Similar is the case with the Garhwali villages who are a powerhouse of information and knowledge but when asked to explain the process, they were unable to put them in words. The age -old knowledge system has not been documented or written and therefore the only method of gaining access to it are the discourses provided by the village elders.

Long interactions with them infers that for them their culture and surroundings form the basis of all their actions and are adopted by them naturally. Their prime motive is to find solutions to their problems within their prevalent belief systems and the available resources.

The goal of sustainability and the pride in one's own culture/belief systems decides all of their problem -solving behaviour.

When human and natural resources work collectively in a common context to achieve any desired outcome, this constitutes a culture. It provides direction, meaning and coherence to all its members and their actions. When we view a situation from the perspective of an outsider, we find culture playing the dominant role and affecting the way people think, feel and behave. But from the point of view of a native, culture is something which is very basic and comes to them naturally. For example, a child born and brought up in a village of Uttarakhand finds it natural and easy to learn to speak Garhwali, Kumaoni and other regional dialects. There are a variety of dialects spoken in various parts of the state and very naturally the child adopts its native style while for him/her the other forms of language remain foreign and alien. Such is the relationship between human being and their cultural setting.

II. *GHARAAT*-THE HIMALAYAN WATER MILL

Traditional watermills (***gharaats*** *or* ***panchakkis*****)** have been an important part of the lives of the Uttarakhand community since years. Watermills harness the kinetic energy from moving water body like river or stream to create energy to move machinery or turbine. A turbine converts the kinetic energy of water into mechanical energy. The force of the kinetic energy is directly proportional to the height and mass of the falling water. Sufficient water supply is required to run the watermill therefore they are not found in all regions. The bank of a perennial river is usually the sight where people make a ***gharaat.*** On enquiry we got to know about some functional ***gharaat*** in the Jaunpur region and this gave us the opportunity to enrich ourself about this marvel of indigenous technology.

We asked one of the villagers Mr Sardar Singh that since when have they been using the ***gharaat***? He replied," We have seen ***gharaat*** in our village since we have opened our eyes…so cannot tell the time when they actually came up in the region." The researcher further asked that according to them why are ***gharaats*** important in the region? Adding to his narrative he said" For grinding of grains, the villagers used to carry the load on their back to far off regions which is quite a difficult task. A mill to grind grain for them in close vicinity would solve their problem. With abundant water resources in the region and other locally available things, the ***gharaat*** is made."

The villagers in their discourses reflect the traditional wisdom which goes in the making and functioning of a ***gharaat.*** There is no information about when and who invented it but true scientific fervour was applied in its creation.

A BRIEF DESCRIPTION ABOUT THE MAKING OF GHARAAT

Gharaat *or* ***Panchakki*** is set up generally along the bank of a perennial stream close to the village. If the stream is at a far off location, the water of the stream is diverted through a channel up to the site of the mill house, which is generally constructed at a point where a waterfall of 8-9 metres is derived from the channel. A long wooden chute consisting of an open channel is made either of wooden planks or carved from a large tree trunk is narrowed down towards the lower end forming a nozzle. The force of the water let through the chute strikes the blades of the turbine in the mill house and rotates the wheel, which in turn rotates the wooden shaft. The average power output of a ***gharaat*** ranges from 1.0 KW to 1.5 KW and the grinding capacity ranges from 4-8 kg per hour depending on water availability and types of grains.

Fig 3.1 ***Gharaat-The Himalayan Watermill***

The components of *a **gharaat*** are as follows:

1.Chute (*patnaala)*

2.Grain Feeder(*Riudi)*

3.Upper and Lower Grinding stones(*Pathar)*

4.Bearing

5.Vertical shaft

6.Runner with hub(*Bhaiyarann)*

7.Lifting mechanism lever*(Nasauta)*

8.Bearing

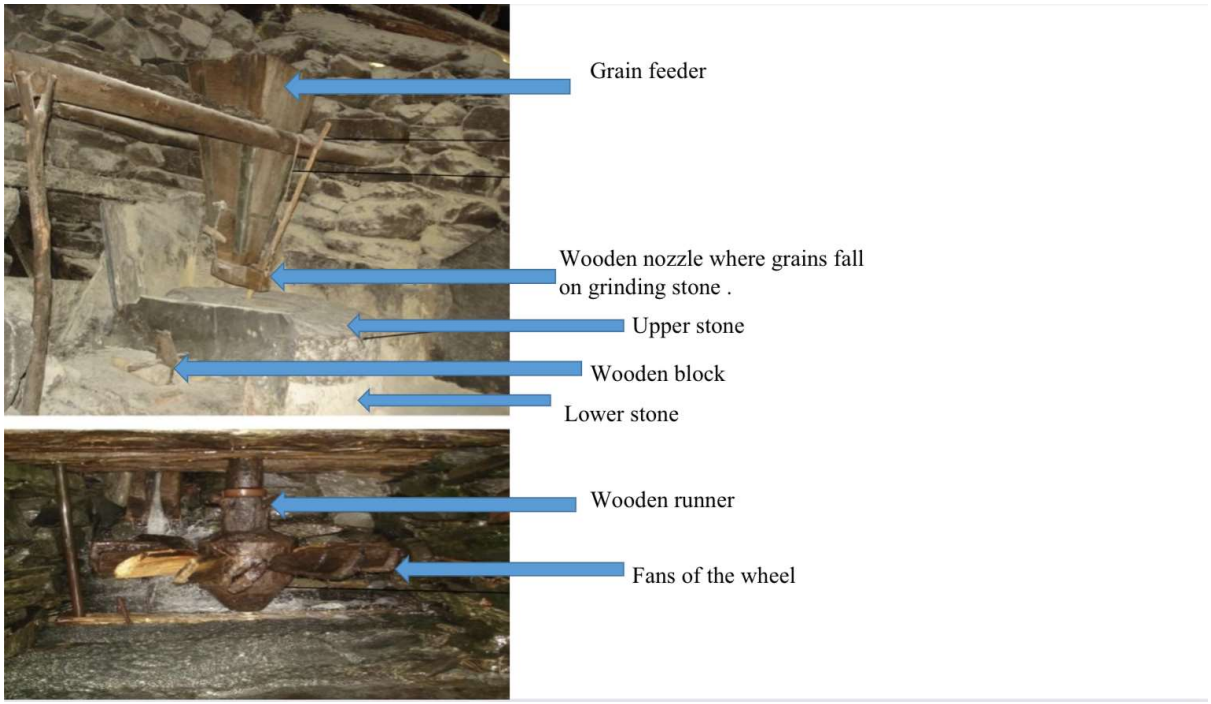
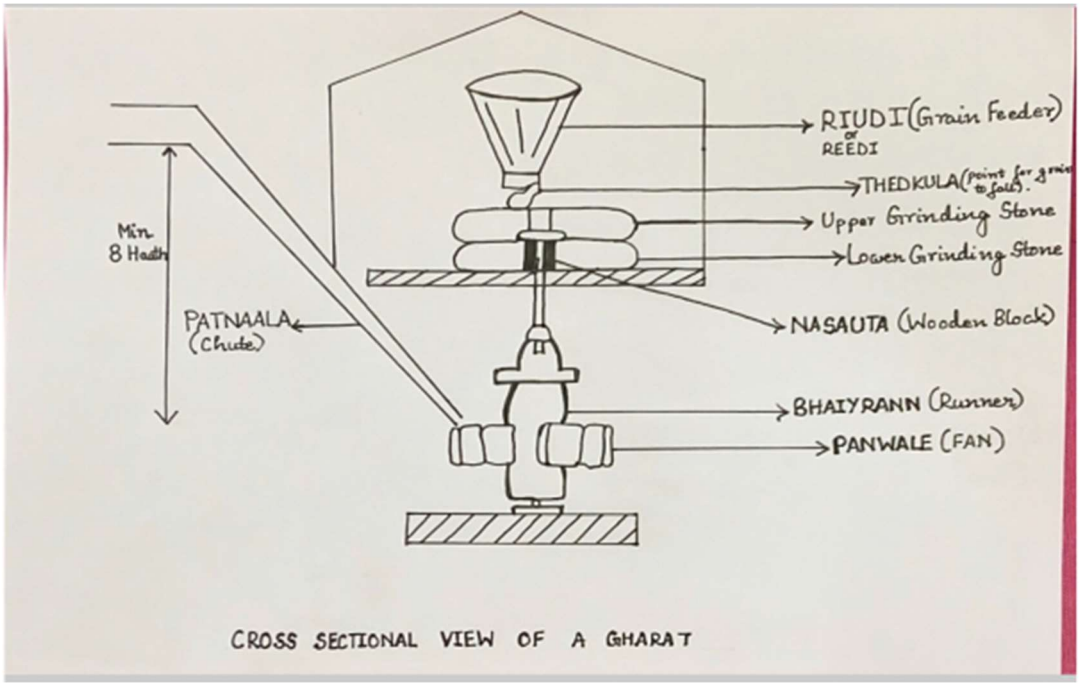


Fig 3.2 ***Components of the Gharaat***



Fi g 3.3 ***Cross Sectional view of a Gharaat***

The researcher talked to a villager Mr Hanumanti about the ***gharaat*** and his reply is as follows,

" In a ***gharaat*** , the '***Patnaala'*** or the tubular passage for water is made to make the water fall with maximum force. The tubular passage is made broad from the inlet side gradually tapering towards the side from where water falls on the '*paanwale*'(wheel)." (Ref Fig.3.3)

We asked him how is the ***patnaala*** made and what is the importance? He replied, "Water from the stream is diverted into a channel *(guul* ' local term').From there the water is directed into a ***patnaala*** made of locally available wood from trees like *baanj, cheed, saal* etc which were very strong and solid."

He further added," Water collected in the *guul* is directed into the ***patnaala*** at a reasonable height of approximately 15-20 *haath*. More is the height water hits the wheels with more energy."

The villagers prefer local traditional ways of doing things which help them to sustain in their environment. Continuous probing by the researcher could not elicit any information about the time period since they have been using the ***gharaat.*** Nobody could elaborate as to when and where it was possibly invented. The physical conditions in the Uttarakhand region are quite harsh for the locals, yet they always come up with indigenous ways of dealing with it. ***Gharaat*** is one such way in which the abundant water resources are utilized efficiently. Today the villagers are modifying this piece of available knowledge as per their need and convenience according to modern times but the basic line of operation remains the same.

The villagers are proud of their acquired traditional assets which have been passed on to them through generations. One ***gharaat*** owner Mr Panwar said, "I have 4 brothers all of which have moved out in search of greener pastures....except me as I was interested in farming. Now in my next generation, I have 2 sons who are studying...As a side business I have also opened a teashop for them...but none of them is interested in operating it....I am operating it because my great grandfathers started it, but it doesn't fetch enough money to fend for the family needs."

There is a specific quality of stone used to make millstones. The researcher went around the village to enquire about this and found that it is a pale blue coloured stone which is found mostly in the rivers and is used because of its sturdiness. A villager, Premchand , age 45 years and ironsmith by profession said "...extreme care is to be taken while choosing stones for ***gharaat.*** We must pick stones very judiciously. Neither very hard nor very soft, it is called *naram garam pathar* because of its variety. They are a good choice as they can sustain the pressure of water."

The researcher then enquired how the village people differentiate '*naram garam pathar'* from other stones. villager, Mr. Suresh said that "the choice of appropriate stone is done while cutting the stone for making the ***gharaat*.**"

A man named, Mr. Gabar Singh, had come to grind his grains at his ***gharaat.*** He intervened and said," We all have grown up seeing the ***gharaat*** culture. They were seen as symbols of prosperity in the village so much that the ***gharaatis*** *(gharaat owners)* used to pay annual tax to the government."

The decline in the number of operational ***gharaats*** in the region adds weight to his narrative. We moved ahead in search of more information about the indigenous hydro- based grinding mill. Passing by the narrow lanes of the village, the researcher came across a man Mr. Padam Singh who was talking to some people about the repair of the ***patnaala***. Initiating a conversation with him, it was found that he was the owner of a non- operational ***gharaat***. When we asked him the reason, he replied in the form of the narrative which is as follows:

"The shaft is worn out and it took me lot of days and a lot of labour to cut a pine trunk and get the log physically transported from the distant forest. A ***gharaat*** requires regular maintenance and owners prefer abandoning them because of low income and high maintenance cost in current times due to change in preferences and lifestyle of people."

One major reason in the closing of ***gharaats*** is lack of enough water in the stream due to scanty rainfall in monsoon coupled with the diversion of water bodies. The law of conservation of energy finds application here in the functioning of ***gharaat***. The force of the falling water pushes the paddles which in turn rotates the wheel. This axle transfers the energy from the falling water to a drive belt which in turn operates some sort of machine. These wheels require some source of falling or flowing water to operate and therefore rivers or streams are required to run them.

Continuing with his reply, Mr. Padam Singh said," Millstones are very heavy and require sufficient amount of water to run them. The cost of transporting them from a distant location involves a lot of hardship and some cost. Due to these reasons, the next generation is not interested in carrying it further as a profession."

An old man Bhim singh said," We always prefer ***gharaat*** produced flour over electric mills as it tastes better and is also good for digestion. The electric mill runs very fast and burns the nutrition of the grains which is not the case with flour which is ground in ***gharaat.***"

The electric mills run at a designated consistent speed as compared to the ***gharaat*** where they alter the speed as per the requisite. This is done by blocking the channel with stone or wood piece. The amount of water falling through the ***patnaala*** gets reduced which in turn reduces the speed of movement of grinding mill. In this manner, the villagers get the desired coarse or fine grinding of grains done.

It is scientifically known that the force of kinetic energy is dependent on the height and mass of the falling water. The kinetic energy of water is present when it rushes through a river or down a waterfall. The villagers have notional understanding of the phenomenon and are aware of the impact or energy of water when it falls from a reasonable height. They talk about the millstones not to be too dense as they are liable to break easily. Instead a stone of medium density is picked but that choice is done on the basis of age old experiences and trial and error sessions at the community level.

With many activities taking place in the surroundings, the child observes and assimilates the information to analyse at a later stage. The expert elders talk about many things and the child innocently picks points of reference from them. The adults do this completely unaware that the child is continuously learning and internalising knowledge.

Human behaviour and thinking occur within meaningful contexts as people conduct purposeful, goal directed activities. (Vygotsky,1978).

When we emphasise on the cultural context of any human activity, then in the process we advance a step further towards our understanding of human mind and its organising capacity in relation to the available resources and the requirements of the culture. Each culture devises its indigenous ways of transfer of these cognitive skills/understanding across various tasks contexts. However the most important point is to find out how the human beings connect in their actions over generations and how does a community devise such methods and transfer to its members.

Social practices and conventions practised over generations enable the elders to transfer it to the next generation through a shared system of belief and meaning making. The thinking tools both material and symbolic developed by a community, are constituent elements of cognition and its development.

A group of children was playing near the village temple. The researcher initiated a discussion with them in order to know their knowledge about ***gharaat.*** A small dialogue between the researcher and the children is as follows:

R: Let us talk about ***gharaat,*** what it is, its function, how it is made, and so on?

C1: It is the place where we take our grains for grinding.....

C2: It is made where we have streams, rivers, flowing water bodies....

R: Why is flowing water required for it?

C3: Because when water falls from a height on '*bhaiyrann*' with lots of energy, then the ***gharaat*** moves.

R: Is this very necessary for the functioning of a ***gharaat***. If yes, why?

C3: The more the flow of water, the faster the '*bhaiyrann*' will move, thus making the ***gharaat*** also move faster.

C4: ....the speed of the ***gharaat*** can be altered by cutting the water supply and subsequently increasing it when required.....water supply is thus the basic requirement to operate it.

R: Tell me is there any type of '*urja' / shakti* which is being used in this process?

C3 :.....(amused) what is the use of shakti in ***gharaat*?** Water does everything on its own.

C4: The water plays the chief role here so the *shakti* of '*paani*' is being used to move the *paanwale* or wheels of '*bhaiyarann'.....*

C5: To alter the water supply, we put small slabs of wood, stones in the *guul.* This alters the speed of ***gharaat,*** thus varying the quality of grounded flour, from coarse to fine and very fine.

In this discourse with the children on the topic of ***gharaat,*** the researcher tried to touch different aspects involved in its functioning. The children were aware of the mechanism involved in the working of a ***gharaat*** but were not able to relate it to the scientific concepts taught in the school. Some of them were in the age group where the scientific concepts involved in the functioning of a turbine are in the syllabus. The link between the two types of learning was found missing by the researcher in the interaction.

A young man who was standing close by intervened and gave us an interesting piece of information that he knows about a bright boy in a neighbouring village name, who has used the technique used in the functioning of *gharaat* to make a productive model. He made a 'merry-go-round' swing for children based on the judicious use of abundant water resources in the region along with providing some form of entertainment to the village children which is

otherwise not available for the local children. This shows how we can utilize our local resources borrowing from our traditional practices in order to create modern technology with minimal expenditure. This model is mentioned in detail under the discussion section.

DISCUSSION

The Garhwali community members believe in sustainability within the limited resources available in their surroundings. The approach of the community elders to extract the maximum benefits of the surrounding natural bounties in the form of water bodies led to the creation of ***gharaat;*** the unique gift of ancient wisdom and technology to the world which was created in the hilly terrains of Uttarakhand. The name and time of its creation is not known however it has been known to exist since time immemorial. The people in the village talk so naturally and simply about its functioning as if they were trained formally in science institutes in order to develop such an understanding although most of them had not attended any formal school.

Local knowledge is produced by the natives on the basis of the shared history and social consciousness. Knowledge created by any group is the ultimate truth for the members even though it may not be reflective of the real world. Local knowledge must be honoured within the traditions of these communities. giving respect to local belief system which fulfils a cultural need and performs a cultural function.

Flour mills are not available in the hills and the villagers required a mill to grind the grains. It is not easy to travel up and down with the sack of grains to grind every time. They faced a problem and looked around to find a solution in their vicinity. ***Gharaat*** is the response of the community to fulfil their needs without making use of electricity or any complex

outsourced machinery. Traditionally known as ***gharaat/panchakki***, it uses of locally made wooden wheels as turbines for the running the mill.

Nature bestows on us a wide range of resources and it depends on the inhabitants how to take out the best from it. The urge to sustain within their own region owing to various topographical reasons, perhaps was the motivational factor for this invention by the hill people. They made optimum utilization of the abundant water supply in their region in order to find solution to their requisite.

The village elders in their various discourses reflect the traditional wisdom which goes in the making and functioning of a ***gharaat*** in a systematic manner. The '***patnaala'***/ tubular passage for water is made broad from the inlet side, gradually tapering towards the other end from where it hits the 'paanwale' to allow the water to fall with maximum force. Law of conservation of energy finds application here as these watermills harness the kinetic energy of moving water body like river to create mechanical energy which is used to move the machine/turbine. The force of kinetic energy is directly proportional to the height and mass of the falling water, and therefore requires continuous water supply. The abundant water supply in the region through rivers and rivulets is a decisive factor to set a ***gharaat***. More the height of the water falling, more will be the energy created hence the height of the ***patnaala*** is 8-9 ***haath.***

The villagers were very sure of their local way of doing things and had full confidence in their traditional methods which help them to sustain in their environment The villagers are now modifying this piece of available knowledge as per their need and convenience according to modern times but the basic line of operation remains the same. There is a specific quality of stone used in a ***gharaat*** because of its sturdiness which is pale blue in colour found naturally in the rivers .

A villager, Premchand, age 45 years and lohar by profession said "...extreme care is to be taken while choosing stones for ***gharaat***. Appropriate stone for the ***gharaat*** is identified while cutting of the stone. We must not pick soft stones because they are likely to break easily and therefore are a bad choice for the purpose."

In the past many non- governmental organisations have introduced modern techniques to aid the villagers in their daily works. Most of them failed owing to the fact that they were not evolved in the context of village settings keeping the various background factors in consideration. These people have limited resources and they need to sustain with these in their surroundings. Their approach is to make the best out of them without the need to look towards the outside world for help every time. They make maximum use of wood in their everyday activities which they get it in abundance in the forest. Tools made of wood can be cut and shaped by them conveniently which is not in the case of iron and other metals for which they have to rely on special people '*lohars'* and their special tools.

It was intriguing for the researcher to find out that the villagers took deep sense of pride in their culture. Talking to them on a variety of issues be it hygiene, sowing seeds, making tools, constructing houses or the way they play hosts to guests everything had a part which clearly depicts that it belongs to them and classifies them from others.

CLASSROOM USE OF EVERYDAY KNOWLEDGE

A student of class VIII named XY, tried to use the scientific ideas of ***gharaat*** in a state level science festival and developed a 'merry -go-round' swing for children using these principles.

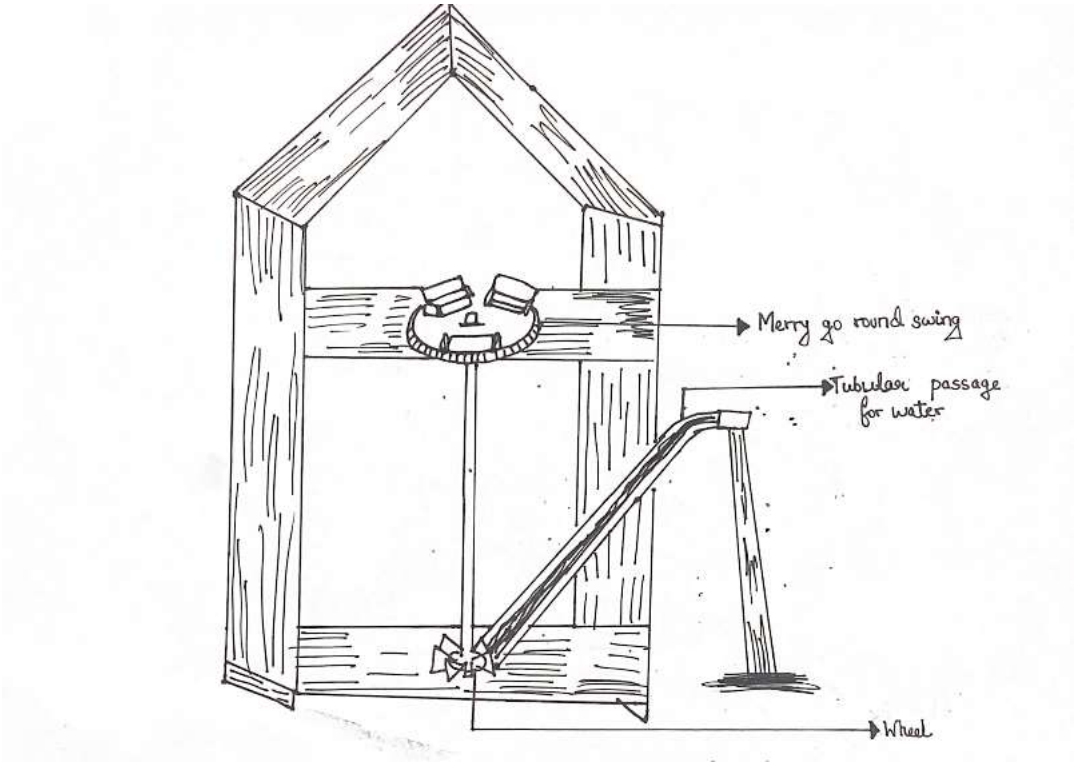


Fig3.4 Model of a swing based on the functioning of a gharaat

He had used the principle of working of ***gharaat*** and explained the process as follows. He said," We had to make a model for the science fest and then this thought struck me, I have seen ***gharaats*** functioning in my village. Seeing the wheel rotating with the help of river water, I tried to make a merry go round type of swing for the children. There is little or no availability of swings for small children in the village. Taking guidance from my teachers, I made this model which has won so many accolades. Now I feel we can put this idea to use in other areas as well."

This 'merry-go-round' swing, no doubt provides some sort of entertainment to the children which is otherwise not easily available for the local children owing to difficult hilly terrains. This model could work well in areas where water is available abundantly and flows with a great force. But what is important for classroom pedagogy is not the development of a new model of merry-go-round swing, but the ability and scope of making scientific principles

of *gharaat* which are part of intuitive world of students, intellectually accessible to them in the classroom. Since everyday knowledge is part of student's everyday world, it is not seen as scientific knowledge. Scientific concepts and ideas are hidden in everyday practices. People learn to use the knowledge without unpacking the neat scientific ideas involved in the production of these knowledges/practices. Creation of a new artefact within the classroom space based on the scientific principles of an everyday artefact changes the perception of students about their everyday world. What was given before become objects of scientific inquiry now. Once children understand the basic principles of transferring one kind of energy /force into another kind in this merry go round swing, they understand many other cultural artefacts from their everyday world scientifically. One sees two ways of transfer of knowledge here: Gharat creating a familiar visual and cognitive space for children and helping them understand the working of the swing and the swing helping children engage with classroom mediated scientific concepts.

At the level of classroom dialogue and pedagogy, one therefore finds a new scope of an intermediary object making multiple contact points for children with scientific ideas embedded in various artefacts like ***gharaat*** from their everyday world. The new object mediates between everyday knowledge and school knowledge of children and therefore, opens up the possibility of children everyday experience scaffold their learning of science in classrooms. This creation also tells us how we can utilize our local resources and combine it with traditional practices to create modern technology with minimal expenditure.

III AGRICULTURAL TOOLS AND PRACTICES

A self- reliant traditional agricultural system is practised in the hills. The villagers make ploughs and other necessary tools themselves with the help of locally available and other metals. Traditional crops of *mandua* and *jhangora* enable people to have enough food grain for

their consumption and plenty of fodder for their cattle. The local traditional knowledge of biodiversity allowed them to make use of the available wide varieties as manure and food.

We visited the house of one villager, Mr Jakhmola who was a farmer by profession. After exchanging pleasantries, we interacted with him and enquired about the farming style prevalent in their village. Mr Jakhmola replied:

"….here in the hills, we follow a popular practice of '*Baaranaaj*'….During the rainy season, people sow twelve different varieties of seeds in their fields. This practice provides us ample amount of food grains for the cold winter months and through this our lands are not vacant during the rainy season."

The practice of '*Baaranaaj*' made them self-sufficient to fend for their needs. It provides them with enough resources through which they could survive in extreme cold conditions. It also gives them multiple options to get nutrition through a variety of crops.

Taking the conversation ahead, the researcher asked him to tell in detail about the local farming practices. His answer is given below in the form of a narration:

"Before sowing the seeds, farmers draw a line as we move the plough. This is called as '*aal*' or '*syuul'* in the local language. The purpose is to help the farmer in sowing the seeds in a straight line…..Otherwise, it may happen that the farmer may forget and sow seeds twice in one place and leave the other patch empty…."

'*Aal*' helps farmers in keeping a track of the position to sow seeds and avoid sowing the seeds twice at the same place, thus avoiding wastage of seeds.

The researcher then asked about the measurement units used by the villagers to measure land in the village? Mr Jakhmola said: "Traditionally, we use two units for this purpose namely,

'*naali*' and '*baath*'. There are no fixed rules about how much seed is to be put in a particular piece of land. But approximately in '1 *naali*' of land some 16 *mutthi* (a handful) of seeds are sowed."

The next question was regarding the exact measurement of 1 *baath* of land. The answer to this was more interesting than the previous one. Mr Jakhmola told that whatever amount of land is ploughed in a day by a villager is equal to 1 *baath* of land. The researcher asked that in a day different people plough different stretches of land. Then how do villagers decide how much is 1 *baath*. He gave a hearty laugh and replied as follows:

"…..*In village life one man- day or working day is equal to the period from morning 7 o'clock to 12 o'clock in the afternoon- that counts to approximately 5 hours a day. People work for only this much time in the fields in the hilly region and usually avoid working beyond 5 hours. This is primarily because the sun is overhead by noon and it becomes very difficult to work in scorching heat of the sun. Thus, the amount of work done in these five hours is equal to a day's work for the farmers in the region and whatever land is ploughed during this time is taken as equal to 1 baath of land for the villager. The reference for a villager is himself, not another farmer*"

We then requested him to elaborate on the relation between *naali* and *baath*. His reply was as follows: "*Approximately 2.5-3 naali of land together makes 1 Baath of land. When we sow the seeds, the amount of seed required would also depend on the variety and size of seeds. 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. of wheat) or 1 maana seed would be needed*…."

We asked him the reason behind this practice to which he replied that, "*If we take two types of seeds -one big sized seed(wheat) and another small sized(mandua) in equal weight and*

compare them, we find that the big sized grain would be less in number as compared to the small sized one and hence while sowing in the fields it may fall short in quantity. Whereas, grains small in size are more in number even though the total weight of smaller grains could be similar to the big sized grains. Thus the amount of seeds required to be sowed in a piece of land also depends on the size of the grains."

A continuation of his narration in this context is as follows:

"*oh child, in villages we people do not bother too much about exact measurements. All of us have our own farms.No one bothers to put any exact mark on it. Some amount of difference does not matter to any of us. After all, it is amongst us only….So we just take 16 mutthi seeds and sprinkle it on a piece of land and call it one naali. Which means, whatever stretch of land we cover with 16 mutthi of seeds is called 1 naali……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 women of the house measure and give seeds from the granary of the house to men for sowing in the fields and for this they have their own measurements.*"

The researcher requested him to kindly elaborate on this topic. He politely expressed his inability 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 put some light in this regard.

We reached the house of Savitri Devi and asked her how does she measure her fields? She replied in the form of a narrative, which is stated below:

"……..the men of the house did this job, as they are the ones who usually plough the land. The women sow the seeds and we use our own understanding regarding the amount of seeds needed for a piece of land….for 1 *baath* land we give 6 *maana* of seeds to be sown. As 1 *baath* is equal

to some 3 *naali,* so for 1 *naali*, we sprinkle one third of this total amount, that is, 2 *maana* seeds."

A new measuring concept, that is, *maana* was introduced to the researcher which was used by the women in the village for measuring small quantities of grains and other things. Therefore the researcher requested Savitri Devi to kindly elaborate on it. 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. At the time of festivals or marriage ceremonies, whenever we have to prepare and give commodities in large quantities, we measure using these units only….."

After getting this detailed introduction to these two units, we went back to the point at which our discussion diverted to a new direction. She had told initially that for one *baath* of 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 villagers in Garhwal region put in some 2 *maana* or 1kg seeds approximately for a good harvest. The women at home used this measurement style.

Maana is a very small unit, which as told by a village lady Savitri Devi is equal to ½ kg. It is made up of wood or copper metal. In villages they use the term *Ser* for half a Kg. So 1 *maana/maani* is equal to half kg or One 'ser'. She also told us that *maana* is a very small unit and is usually used to measure food grains while cooking at home.

Paantha which is shaped as a 'U' shaped tumbler and is made of wood or copper metal is a relatively bigger unit. According to Savitri Devi, it is equal to 2 kgs or 4 *maanas*. It is used more often in barter system for measuring large amount of grains in exchange for services within the community.

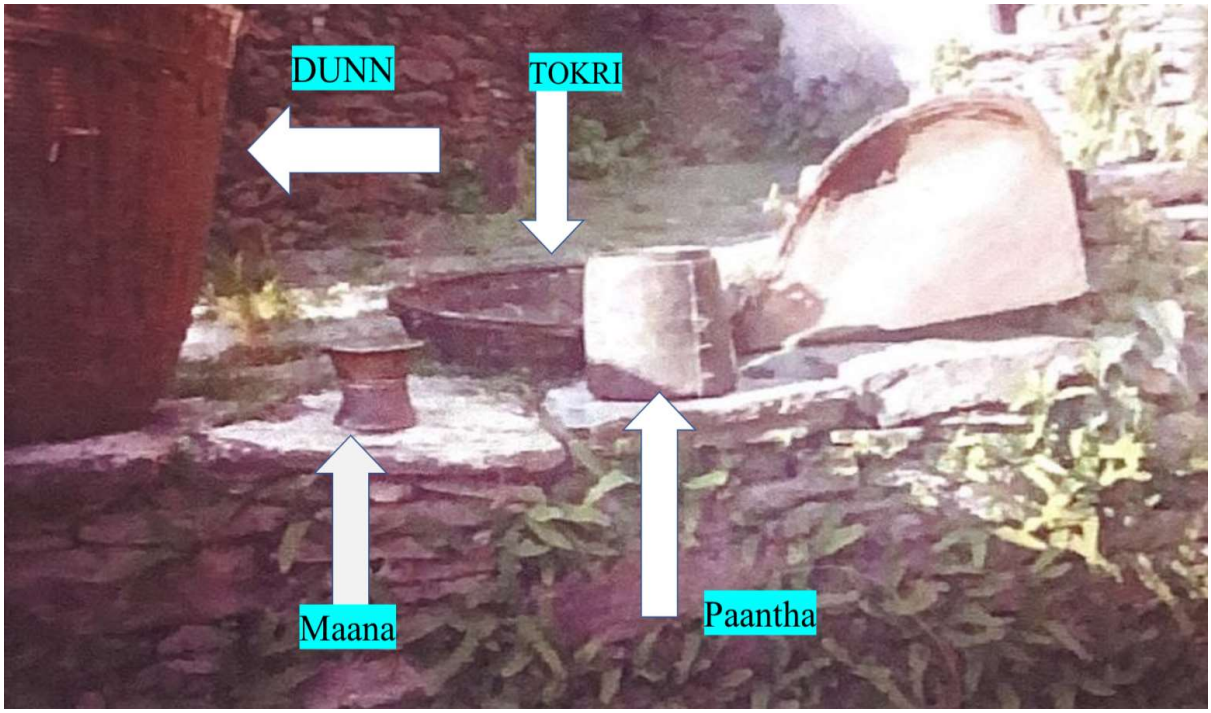


Fig 4.1 ***TRADITIONAL UNITS OF MEASUREMENT***

After getting these details about these two units, we went back to the point at which our discussion diverted to a new direction. Savitri Devi initially said that for one *baath* of land she gives around 6 *maana* seeds, which are equal to 3 kg. So now we can say that for 1 *naali* of land, the villagers in Garhwal region put in some 2 *maana* or 1kg seeds approximately for a good harvest. The women at home used this measurement style.

Savitri Devi then talked about another way of measuring land. She said that people can sprinkle an amount which may be more or less than 16 *mutthi* seeds. Therefore in order to keep the discrepancy low in farming practices, the villagers formed an idea that four seeds should ideally be sprinkled in an area equal to the foot of an ox. The researcher was intrigued by how it was possible for the farmer to measure such a small amount so accurately every time. Her reply in the form of a narration is as follows-

"There is no exact measurement but only an approximation. It only saves us from putting too much or too less amount of seeds in a particular area. It helps in equal distribution of seeds and we are able to measure our farm lands with more precision."

On asking her how does the distribution of land takes place amongst the children in a family? She said that if a property is to be distributed then it is done with mutual consent or sometimes with the help of family, friends/elders. As a local practice, the elder brother gets an extra piece of land and also the east facing portion of the house. We asked the reason for such a practice. Her reply to this is as follows:

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

But our inquisitiveness did not end here and we asked her what happens in case the younger brothers do not agree to such an arrangement. With a sweet smile on her face she replied:

"You people living in big towns are only concerned with the exact and equal distribution of any commodity. But in villages there is a different way of life. All of us believe in taking mutual decisions in consensus with all family members but, in case, there is a problem, then they have to abide by the decision of the village panchayat."

Thus, with an intention to explore these activities, people engaged with 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 village life.

After this detailed conversation, the researcher moved ahead and came across the house of another villager Mr Rajendra Kala, who was sitting and chatting with a group of people in front of his house. The researcher sought his permission to spare some time so that we may interact about the village and their lifestyle practices. He welcomed us and said,"……. in villages we consider our guests as God and take every possible effort to look after them."

He told us that maana was a smaller unit of measurement equal to ½ kg or 1 Ser as compared to *paantha*, which is equal to 4 *maana* or 2 kg. During the time of marriage and other such social gatherings, people used to give sweets to the groom's family in a unit called '*Dunn*'. It is measured in terms of *paantha* itself, as it does not have any specific defined weight of its own.1 Dunn is equal to 16 *paantha* which is equal to 32 kg. They also make '*tokari'* which is a basket shaped container made up of locally available ringaal and is used for measuring and giving large quantities of commodities.

One *tokari* or basket is equal to 4 '*paantha*',which is equal to 8 kg. Similarly ,2 baskets of 8 *paanthas* will together be equal to 1 *duun,* which equals to 32 kgs. The villagers used the indigenous units of measurement for doing all types of calculations. It is explicit that the Garhwali villagers developed their measurement system on two basic units. These two units help them in measuring small to large quantities of goods in their day- to- day life activities in a precise and convenient manner.

TRADITIONAL AGRICULTURAL TOOLS IN A GARHWAL VILLAGE

While doing agricultural activities, the villagers use different agricultural tools which they make themselves or by the village carpenter. These tools are different from the universally available tools because of their inherent qualities, which make them specific to their requirements. To probe this specificity, the researcher visited a number of houses in the village

in order to get some first- hand information. When we visited the house of a villager Mr Rajendra prasad, he was sitting with his family members while the ladies of the house were busy drying the harvest for future use. We requested him to kindly show us the traditional plough and other such tools used by them in farming. He took us to the lower floor of the house where the tools are kept usually in the off-season. There we saw a traditional plough used in the garhwal villages and asked him to tell us about it in detail.

He told that in the region people do not make very big tools. The average height of the plough is between 3.5 to 4 *haath*. 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 like to keep the heights of our tools accordingly so that people can use them conveniently…...If you look around , you will find that the bulls here are comparatively shorter than the ones found in the plain regions. Therefore this is an important point of consideration while we make our tools….."

On observation, it was found that the bulls and other animals in the region were actually quite small in size. Probably, the 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 of heavy built as the ones found in the low lying regions, then it would have restricted their free movement in the hills. Also it would be risky not only for them but also for the farmers to manage them in case of any emergency…...Therefore for a small bullock, we will have small ploughs which are easy to handle and more user friendly. In a traditional plough, the length of the long rod is kept between 7-8 ***haath*** approximately. This rod is called '*laat'* in local language."

His father, a more experienced person was sitting with him and added to this," The distance is kept only so much in order to prevent the *nisdaa (*lower part of the plough meant

for digging) from touching the bullock's feet. This will otherwise affect the efficiency of the plough."

Fig 4.2 ***A traditional plough in Garhwal region***

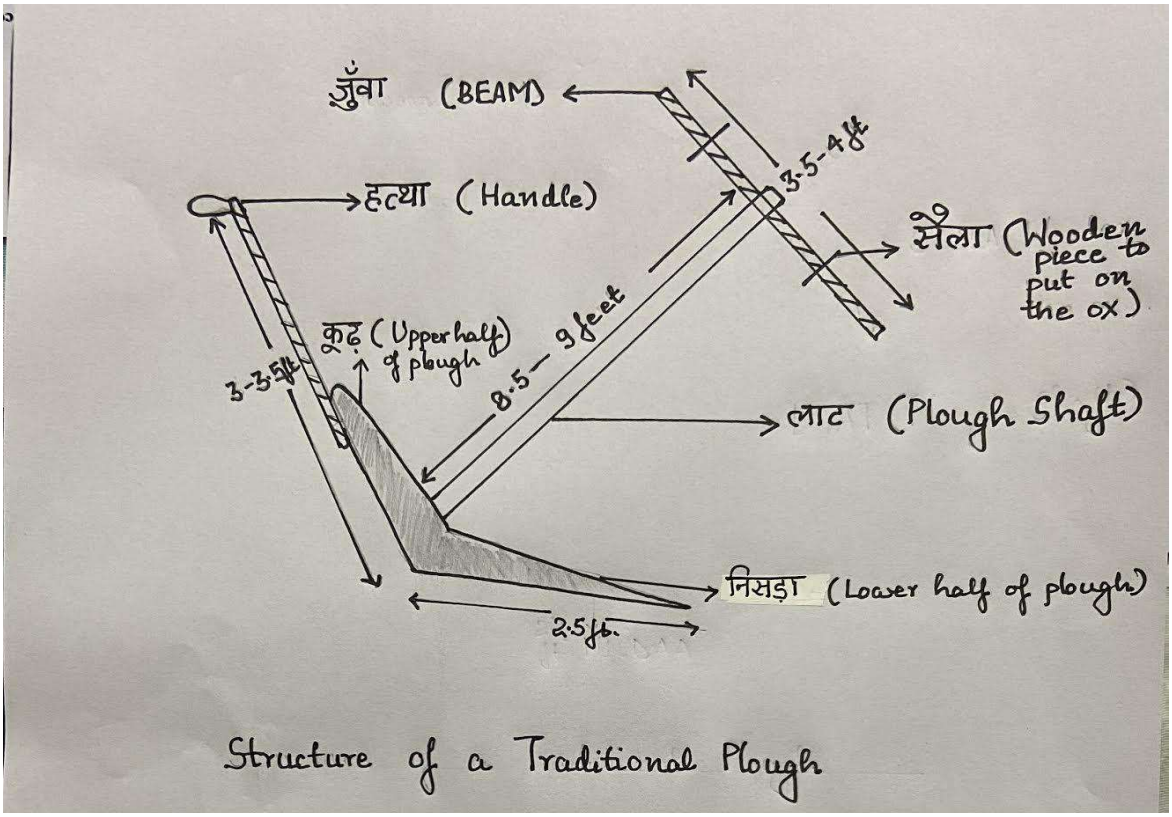


Fig 4.3 ***Structure of a traditional plough***

The villagers use the locally available wood of *baanj* tree for making the lowest part of the plough which is used to dig the soil. *Baanj* tree is used because it is very hard and does not break easily on hitting the stones under the soil.

Mr Rajendra added," As *baanj* tree grow extensively in this region ,so we use it because of its easy availability. But now as the government has put ban on cutting of trees, we are forced to use iron instead. We do not like it because we have to go to the ironsmith (lohar) if we encounter any issue with our tools."

Adding to this another villager named Satender said," We could easily mend our tools made of wood with the help of another one called '*bansula*' which was made by the farmer himself for any kind of repair work of tools."

The researcher then went to a neighbouring house of another farmer to gather more information about tools used for agriculture in the region. Mr Goniyal said, ”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 in this regard. His narration is given as under:

“Here in the hills, the field are not flat and spacious. Rather they are made by cutting the steep slopes into terraced farmlands thus making it feasible for farming purpose…….Because of this there are some very sharp and narrow bends where bullocks cannot reach. Such stretches of land are tilled by the women and children with the help of *kutli*, a small tool in the shape of a *Favda,* to help the farmer in digging the entire field….”

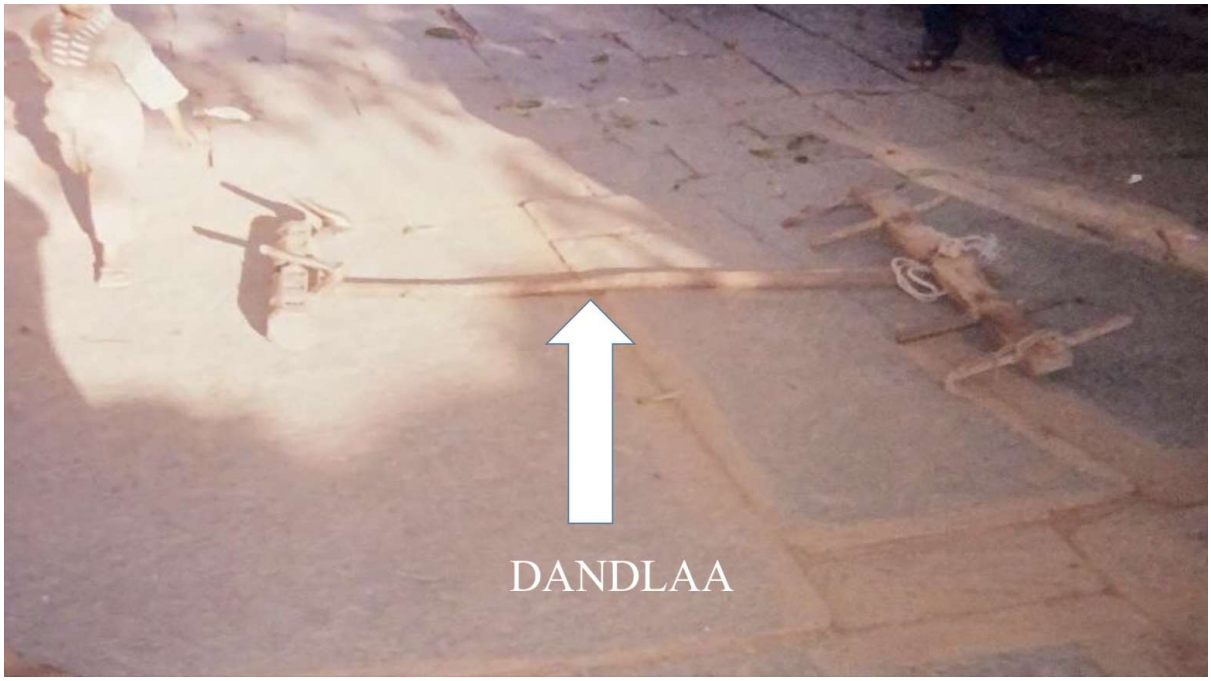


Fig 4.4 ***Traditional agricultural tool - Dandlaa***

Fig 4.5 ***Traditional agricultural tools***

Fig 4.6 ***Traditional agricultural tool- Paataa***

The manner in which the villagers in the region make their tools and carry out agricultural practices shows their 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 indigenous knowledge and understanding of doing their everyday activities over a number of years which guides them to tackle their environment efficiently.

DISCUSSION

The traditional agricultural system in garhwal embraces the most important feature of being holistic and comprises all land related activities starting from cropping, animal husbandry, forestry etc. These components are in organic linkages with each other. Their 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-anaaj'* 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 fulfils their daily need of necessary nutrition at their level of self- reliance.

The available land quality in the region is of two types-irrigated and non- irrigated 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 food grains like *kodo/mandua* (finger millet*), jhangora* (barnyard millet) etc. The cycle of crops is so planned by these villagers that no piece of land lies vacant. This strategy to cultivate a wide variety of crops helps in providing balanced nutrition and

enough food grains to the villagers throughout the year by allowing them to make the most of the many ecosystems of the environment.

On observation it was found that these villagers don't 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, sowing, weeding, harvesting, threshing, carrying the produce from field to houses, storage of food grains 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 *nisdaaa*. 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 area 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 food grains. 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 a swell 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.

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 make 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 based on market- based resources. The villagers keep in mind the local and easy 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.

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 ***pathaals*** in roof making and so on. The indigenous knowledge system is based on the perception and interpretation style of the natives while some behavioural 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.

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 formal inducted 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 the child is able to do those works properly, then only he/she will be asked to start ploughing and do the main important job. 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 essential for the children to take part in any activity, which they want to learn and pursue.

SUMMARY OF DATA ANALYSIS

Analysis of three major activities of Garhwali and Jaunsari communities of Garhwal region reveal the ways in which these villagers perform their everyday activities and how logical these activities are from the point of view of everyday scientific reasoning. The analysis reveals the presence of many scientific ideas in the everyday practices of these Garhwali communities. The scientific reasonings are not very explicit in these practices, yet they form an integral part of the lives of the natives as this knowledge allows them to adapt efficiently to their ecological contexts. These age- old practices are culturally transmitted that enhance the sustainability of the community. They form a part of tacit knowledge of Garhwalis and Jausaris.

The relationship between these practices and the surrounding ecological factors in the region is strong. As *pathaals* help in keeping the house warm in winters and cool in summers, the villagers continue to use them in their houses even if they are aware of concrete structures in the neighbouring urban areas. In a few cases, the villagers expressed their disappointments in how the market is influencing the younger generation to make unsustainable and ecologically less friendly choices. Some villagers find it easy to use tin and asbestos sheet roofs and not *pathaals.*

The 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. Invention of specific indigenous strategies by the Garhwali villagers are the main reason for their successful and fearless stay in the tough Himalayan terrains.

The sample activities of house construction, 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 surroundings ecological factors in the region. The narration provided by one villager Mr Rajendra Prasad Kala reveals the underlying logic behind using *pathaals* in making the roof of the house. He said that it helps in keeping the house warm in winters and cool in summers. The disappointment is evident in his voice, as now forcefully he and other villagers have to use tin sheet roofs due to the existing situations. The cropping pattern is shaped entirely on the basis of prevailing ecological conditions in the region. Mountain agriculture is totally dependent 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.

People in traditional societies possess indigenous knowledge, which helps them in variety of everyday activities like curing ailments, using irrigation facilities, managing natural disasters, tool making and their application and so on. These people produce this local or popular knowledge in their effort to deal with the surroundings using the locally available resources. Amongst the villagers, technology is nothing but a way of life.

The knowledge base of these everyday practices may be informal in nature but it makes the villagers confident enough to deal with the surroundings. All their daily needs are met in this manner. As only the men folk do ploughing job in fields hence they plough the fields of people who cannot do it for themselves such as elders, women etc .and they do not expect anything in return. Such is the feeling of cohesiveness amongst the villagers that everybody's work is done so that no one has to seek help from outside the village. Beginning from house construction to agriculture or any other work, the entire village works together as one big family to get that job done. There is a developed sense of social coherence within a community which binds its members together.

Cognitive development and culture are inter connected through the common goals and values of the community members. The material and symbolic artifacts support the thought process with the available cultural resources for meeting the goals. The higher mental processes mediate the development of the thinking process amongst the children and initiate cultural goals thus making them active participants of the community practices.

In the Garhwal region, the villagers proudly talk about their rich cultural practices and artifacts and we get multiple explanations for the same. But there is no documented explanation for these therefore everybody articulates with their own level of understanding. Culturally organised social practices help them to share this indigenous knowledge with each other and the future generations. The mental functioning of an individual gets linked with the socio historically formulated means of thinking with the application of these 'tools for thinking'. There are ample examples of the relation between cognitive development and the cultural sharing of knowledge in the developmental literature.

The Indigenous psychology approach represented a fundamental shift in scientific paradigm, that is from a positivistic conception of causality. Science/ technology is a product

of the collective efforts of wisdom borne by the members of any culture / community in their struggle for sustenance with the help of the available resources in their surroundings. But in our quest for universal and infallible scientific law/ rules we tend to limit the scope of science as confined to a single cultural framework.

In the subsistence economies, socialisation plays an important role in achieving the goals of survival and sustenance and the dominant cultural practices in the community provide ample support to this belief. The barter system, house building practices, the *gharaat* system, local measuring units are all testimony to this fact.

CHAPTER 5

SUMMARY FINDINGS AND DISCUSSION

The present research aims to study the everyday practices of indigenous communities and explicate the scientific ideas and concepts embedded in these practices. Additionally, it analyses the social and psychological processes as well as the everyday pedagogy that impact the development of thought and learning amongst indigenous community members. Each culture adapts to the environment in its own unique style that is specific to their group's norms and belief systems. The availability of resources and prevalent ecological conditions influence actions undertaken by the natives while performing everyday activities. The mandate to understand the indigenous knowledge of traditional indigenous communities and how they engage in various discourses while dealing with scientific and everyday concepts was the chief inspiration behind this study.

This study aims to explore how different cultural artifacts mediate every day and scientific concepts used by people, the nature of understanding of scientific concepts among villagers, and the various cultural protocols/prototypes that people put into use.

A pilot study was conducted to help the researcher familiarise with the area, its people, and prevalent cultural activities. It also helped in revising the checklist of questions developed for data collection in the final study. A set of activities were identified from the everyday activities of the Garhwali and Jaunsari communities. For the main study, the researcher stayed in the field for a period of six months. Detailed interviews were conducted, with all those engaged in the sample activities. The interviews performed and observations done were later transcribed and analysed using thematic analysis technique.

The following questions guided formulation of research objectives:

1. How do cultural artifacts and practices mediate the everyday understanding of scientific ideas and concepts?
2. How do different cultural groups organise their everyday concepts and scientific ideas?
3. How do cultural tools, symbols, social interactions, and material conditions affect the process of knowledge development in the communities?
4. What implications does everyday knowledge of people have for classroom pedagogy for science?

OBJECTIVES OF THE STUDY

The broad objective of the study is to explore the everyday knowledge of scientific ideas and practices of the Garhwali and the Jaunsari communities of the Garhwal region and their relationship with their eco-cultural systems.

The specific objectives of the study are as follows:

1. To study how Garhwalis and Jaunsaris organise their scientific knowledge and ideas in everyday life.
2. To study how different eco-cultural concepts and artifacts mediate everyday knowledge and practices of science in these two communities.
3. To study how distributed these cognitions are and how individuals use them to carry out a cognitive task.

SELECTION OF SAMPLE AND CULTURAL ACTIVITIES

A pilot study was conducted in both the communities to explore cultural practices. Two communities, the Garhwali and Jaunsari from the Garhwal region, were identified for this

study. These particular communities were chosen for the study because of the researcher's familiarity with the regions and its people. The cultural activities that were selected for analysis involved house construction, agricultural tool-making, and the operation of the locally available hydro-power based grinding mill called *gharaat*. The reasons for selecting these three activities are as follows:

1. Every member of the Garhwali and Jaunsari communities is involved in at least one of these three activities.
2. These activities are based on some scientific ideas.
3. These activities have evolved over several centuries in this region and are central to the lives of the inhabitants.
4. These activities shed some light on how people develop an understanding of their surrounding world and how they use this knowledge in daily activities.
5. These activities allow one to understand how different communities respond to their eco-cultural systems and beliefs.

RESEARCH DESIGN, TOOLS, DATA COLLECTION AND ANALYSIS

Focussed ethnography is used to study how indigenous community members engage with scientific ideas and concepts, how they communicate their tacit knowledge of their lived world (that involves scientific ideas and concepts), how they respond to the eco-cultural demands of their regions in everyday life, and how the knowledge is transferred to the next generation. Two ethnographic tools are used for data collection: observation and semi-structured interviews. The data were collected over a period of six months and analysed using thematic analysis technique.

SUMMARY ANALYSIS AND DISCUSSION

The present study assumes that knowledge is created in indigenous societies through the interplay between cultural, social, geo-physical factors, coupled with practical experiences in informal settings. The present chapter discusses the results revealed in the previous chapter, concluding and discussing implications and directions for future research. The observations and interview data reveal that the manner in which villagers perform everyday activities like house construction, agricultural tool-making, and milling reflects a systematic and region-oriented approach. They use locally available resources to face the extreme climatic conditions prevailing in the region, engaging in complex multivariate judgments using their everyday knowledge of scientific ideas.

The reasoning behind their judgements could be considered logical since it involves the many embedded scientific concepts inherent to the Garhwali and Jaunsari communities. While the scientific and logical reasoning involved in their everyday practices are not very explicit, they form an integral part of native life as they allow individuals to adapt efficiently to the surroundings. These practices are based on the culturally transmitted indigenous knowledge of the Garhwali and Jaunsari villagers; such knowledge is typically aimed at increasing the sustainability of the community. Given below is the summary of concepts discovered in the course of enquiry.

5.1 CONCEPT OF EQUILIBRIUM/*SANTULAN* IN THE ROOF CONSTRUCTION

The narratives of villagers with regard to the house construction practices of the region reveal their in-depth understanding of local ecological conditions. The layering of the roof is one of the most important aspects of house construction. Villagers in the Garhwal region use

deodar logs or beams owing to their long life and strength. In the harsh terrains of Uttarakhand, the only desire of native villagers is to achieve the locally earmarked benchmark for performing mundane activities which help them sustain a living. They strictly abide by the wisdom of community elders. Most natives do not really have any logic or explanation for their actions; they base their actions on the witnessed reliability of tools and methods, and depend on them fully.

During roof construction, the natives aim to reduce the *bhaar* of the heavy *pathal* roof on the walls of the house. The villagers use extended supports made of wood or stone called '*satir',* which convert vertical force/*Bhaar* of the roof into horizontal force, thus sparing the walls of the house from experiencing the entire load of the roof=.

When we try to probe the community for its understanding of the concepts behind this activity, we get ambiguous reactions. The elders spoke about it vaguely, as 'siddhai' or 'bhaar' of the object. They considered it essential to maintain the proportion of length and breadth of a building so that it remains erect. In the entire conversation, none of the villagers used the term 'force' and instead referred to it as bhaar or load. However, there was no evidence that their understanding of this concept is less than that of others in any way. The manner in which they manage their daily activities with a low and less varied resource base makes the entire process all the more commendable.

5.2 CONCEPT OF ANGLE/SLOPE

The villagers measure angle or slope using their own indigenous units. The most commonly used unit of measurement in earlier times was '*haath*'. The villagers measure the length and elevation of objects in terms of *haath.* According to the elders of the community, there are no specific instruments available to them for measuring them. They depended on the

mason or *mistri* for the same as they believe that the mason knows the best slope required for roof construction. The mason would use *haath* as a measurement unit, keeping the slope of the roof accordingly at 4-4.5 feet maximum.

Haath/hand is a widely used unit of measurement in the Himalayan region. Be it in house construction, agriculture, or other kinds of tasks, the villagers extensively used *haath* and *mutthi* (a handful) as units of measurement; it suffices to say that these units are preferred. The sense of familiarity with these units makes calculations easy for the villagers. The deep-rooted cultural traditions and practices which have been passed/transferred across generations shape the thought process of the Garhwali and Jaunsari villagers. The level of comfort in their application is primarily responsible for its wide usage.

'*Suut*' i.e. the thread is the most easily available and commonly used means to measure the accuracy of any line. If two walls are found to be equidistant using '*Suut*',that means they are coming out straight. For this purpose they also used an 'L' shaped locally made instrument called '*Guundiya*' which is made of wood or metal. These people do not talk in terms of angle but instead make use of the term '*lambaai'/slope.* which means the same thing.

5.3 DISTRIBUTION OF FORCE

All the houses which were visited during the study did not use any separate pillars in the roof construction process to distribute the force/load. However, it was found that some beams roughly run across rooms diagonally. The cross-sectional beams running across the room in these houses not only help in converting the large amount of vertical force into horizontal force but also distribute it uniformly between all four walls such that the entire force does not fall on a single one. This provides more stability, strength, and longevity to the house, a fact which supports the argument that many houses in the region were able to withstand

earthquakes from time to time. The placement of the *sahwaan* between the roof and vertical walls is a clear example of the indigenous knowledge of the communities' people. The lack of them would make the structure weak and liable to break easily.

In the studied villages, walls are built with the help of big boulders and small stones which are placed in a manner that there are no gaps or crevices between big boulders. Having a well-packed broad wall helps prevent breakage or collapse during climatic mishaps like earthquakes, strong winds etc. when it sways as a single unit and this prevents it from falling and breaking. The dwars /wooden beams are put horizontally across the other two walls in order to distribute the load of the entire roof. Thus, the four walls of the house uniformly share the weight of the heavy roof.

The villagers were aware of how a minimum amount of slope or elevation is required for roofs to prevent the accumulation of water or snow during the heavy rains and snowfall prevalent in the region. However, the villagers do not use the term 'angle' to define slope. There were no specific instruments available to measure the slope or angle; the villagers depended on the *mistri*/mason's sensibilities. Mason used the hand as a measurement device for the same and kept the elevation of the roof accordingly at 4-4.5 feet maximum.

5.4 CHOICE OF CONSTRUCTION MATERIAL, ECOLOGICAL CONDITIONS AND MAINTENANCE OF ROOM TEMPERATURE

The prevalent ecological conditions in the region force villagers to keep their houses at low heights. As the village is in an extremely cold region of the state, it may be judicious to construct smaller houses to keep them warm and comfortable during winters.

The use of *pathaals* or stone slabs during house construction is another fine example of folk wisdom. According to the villagers, they help keep houses warm during winter and cool in summer. Although they could not explain the process using scientific terms, their choice of stone as construction materials reflects their rich local knowledge system.

Hilly areas in the Garhwal region face the problem of extremely cold climatic conditions; the usage of *pathaal* and wood in house construction safeguards the natives from this extremity. These materials are also effective in keeping the houses cool in the summer season. Being a good conductor of heat, stone does not have good insulating properties. Hence, it conducts heat inside the room away quickly. Heat is prevented from entering the house fully by the wooden beams used in the roof. Wood being a bad conductor of heat, absorbs heat only from the surfaces it touches. As such, only a very small amount of heat remains trapped in these houses. Heat is dispersed by the stone used in making the walls of houses.

The villagers had a notional understanding of thermal conductivity of dense materials, passive cooling, and thermal lag; however, they used different terms while referring to them. An implicit understanding of Pythagorean principles was identified amongst the villagers; they understood the relationship between height, weight, and length of the house in the context of area and weight. The underlying As-If assumptions employed in the everyday activities of villagers is very necessary in order to understand the concept of probabilities of choosing one way of doing things over the other.

5.5 LAW OF CONSERVATION OF ENERGY

The law of conservation of energy finds application in the functioning of the *gharaat* mill. The force of the falling water pushes the paddles, which in turn rotates the wheel. The axle then transfers the energy from the falling water to a drive belt which in turn operates the

mill. These wheels require some source of falling or flowing water like rivers or streams to operate.

It is scientifically known that the force of kinetic energy is dependent on the height and mass of falling water. The villagers have notional understanding of the phenomenon and are aware of the impact or energy of water when it falls from a reasonable height. They also mentioned that the millstones must not be too dense as they can break easily. Instead, a stone of medium density is picked; the choice of stone is made on the basis of experience and trial and error sessions at the community level.

Some more findings are summarised under the following subthemes:

HOLISTIC AND ORGANIC FARMING

The traditional agricultural system in Garhwal embraces a holistic approach. It consists of all land-related activities starting from cropping, animal husbandry, forestry etc. There are organic relations between these activities. The traditional agricultural system is 'closed', self-contained, and self-reliant. The agriculture system is adapted to the mountainous region, helping villagers face the brunt of the extreme climatic conditions and providing them with the required nutrients in the form of the wide variety of food grains cultivated in the region. The prevalent cropping pattern wholly relies on the ecological conditions. The villagers follow a multiple crop system called '*baaranaaj',* implying that they do not rely on any one single crop. Through this system, villagers gain access to a wide variety of crops, which helps fulfil their need for balanced nutrition through self-reliance.

Land in the region consists of two types: irrigated and non- irrigated land. The former has ample scope for irrigation through streams and canals; it is used to sow finer grains like

wheat, rice etc. Un-irrigated land does not have any provision for irrigation, and is dependent on rain. Such land is used to grow coarse food grains like *kodo/mandua* (finger millet), *jhangora* (barnyard millet) etc. The cycle of crops is planned out by villagers such that no piece of land lies vacant. While this strategy helps cultivate a wide variety of crops and sustain the communities, multi-cropping also allows them to make the most of the land they have access to.

WOMEN AND AGRICULTURAL PRACTICES

On observation, it was ascertained that the villagers don't have any absolute form of knowledge. Their information system continuously evolves according to their needs and prevailing conditions. The role of women in these agricultural operations is also very significant; their contribution works out to be more than three-fourths of the labour required for agriculture. Women participate in almost all agricultural activities including land preparation, sowing, weeding, harvesting, threshing, transportation of produce, and storage of food grains, etc.

KNOWLEDGE OF WOOD AND MAKING OF AGRICULTURAL TOOLS

An observation of the agricultural tools used by villagers revealed their vast knowledge of 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 the *baanj* tree to make the lowest part called as *nisdaaa*. A villager Ramesh Chandra mentioned that this specific tree is used because it is very hard and does not break easily while digging up the soil.

Due to rocky terrain and the lack of sufficient irrigation facilities, most of the cultivated area is left unirrigated in the region. Villagers are forced to rely on rainwater for the irrigation

of their fields. More than 80% of the total land is used for growing food grains. The grains and vegetables grown on their land are largely for personal consumption. Alongside the crops, villagers also plant some fruit trees for 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. Hundreds of years of experience is visible in everyday practices seen across the communities, such as terracing of farmlands, construction of houses with sloped roofs, use of *pathaals* in roof making, and so on. Perhaps the undocumented nature of these indigenous strategies makes it unacceptable in laboratory situations. The indigenous knowledge system is based on the native perception and interpretation of reality; some behavioural 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; they are highly adaptive to specific situations and are sustainable.

IMPACT OF ECOLOGY ON SCIENTIFIC PRACTICES

The sample activities of house construction, agricultural practices, and tool making observed as a part of this study convey the idea that there exists a relationship between these practices and the surrounding ecological factors in the region. The villagers' narrative reveals the underlying logic behind using *pathaals* in making the roof of the house. The cropping pattern is decided entirely on the basis of prevailing ecological conditions in the region. Such mountain agriculture is an apt example of 'nature-subsidized' agro systems which solely rely on natural resources to function optimally. It relies on sunlight, rainfall, crop residue etc., and

is controlled by ecological principles that embrace sustainability. It can be inferred from the discussion that the specific indigenous strategies employed by the Garhwali and Jaunsari villagers are responsible for their successful occupation of the tough Himalayan terrain.

People in traditional societies possess indigenous knowledge which helps them in a variety of everyday activities like curing ailments, irrigation, disaster management, tool making, etc.. These people produce indigenous knowledge in their effort to deal with their surroundings using locally available resources. Amongst the villagers, such knowledge is their way of life.

COLLABORATION AND SHARED WORKFORCE

The knowledge base of everyday practices may be informal in nature but offer villagers enough confidence to deal with their surroundings. All their daily needs are met in this manner. As only the men folk plough the fields, they collectively plough the fields of people who cannot do it for themselves such as elders, women etc. without expecting anything in return. Such is the feeling of cohesiveness amongst the villagers that everybody's work is done so that no one has to seek help from outside the village. From house construction to agriculture, the entire village works together to get the job done.

Frankenberg (1966) proposed that the common interests inherent to various goals like religious, economic, social etc. brings the members of a community together. There is a developed sense of social coherence within a community which binds its members together.

Cognitive development and culture are inter-connected through the common goals and values of the community members. The material and symbolic artifacts support the thought process with the available cultural resources in order to meet the goals. The higher mental

processes mediate the development of the thinking process amongst the children and initiate cultural goals, making them active participants in the community's activities and practices.

The current study supports the finding that knowledge is a social construct. The traditional Garhwali and Jaunsari communities perform their basic activities in mutual consultation and harmony. Mutual consultation is a routine that is accorded a very high importance in the community. Knowledge is a collection of observations garnered through an individual's perception of his/her surroundings; the various ideas are then developed through an interactional process. This local knowledge is based on age-old practices, which have been developed by taking into consideration social, political, economic, ecological, as well as cultural practices.

LEARNING THROUGH PARTICIPATION

The village comes together to perform activities like house construction and agriculture. The transmission of knowledge and skill development in the Garhwali and Jaunsari communities takes place through experience and practical learning. Scaffolding comes into practice; as the elders transfer their knowledge of indigenous practices to the younger members of their community. Interviews with villagers indicated that the children or novices have to pass through a series of stages before getting formally inducted into the primary workforce. According to the villagers, a child is first engaged in odd jobs like getting fodder for the bullocks, washing them, tilling the small leftover corners of the field, and so on. When the elders are convinced that they are able to do these jobs properly, they are started on jobs like ploughing, sowing seeds, etc. The elders believe that successful learning involves active participation. Therefore, it is compulsory for all the novices or children to take part in the activities they want to learn. Indigenous knowledge is thus directly or indirectly transferred into the minds of growing children by adults in a systematic manner.

Time and again, it has been advocated that the human mind develops by adopting historically and culturally established knowledge systems. An individual undergoes cognitive development; the cognitive structures that eventually develop have a historical and cultural base.

CULTURAL BELIEFS AND DESIGN DECISIONS

The variation in beliefs leads to various discursive practices in the Garhwali and Jaunsari communities. The Garhwalis and Jaunsaris use an odd number/*khot* of pillars i.e. 5, 7, 9 in their houses. Since deodar logs more than 13 *haath* in length would be difficult to carry to construction sites located in remote areas, communities decide to make their houses 5-7 *haath* in length.

For the Jaunsari people, the number 5 is considered sacred as they revere the 5 Pandavas as their ancestors and therefore they prefer to do everything in *khot* or odd numbers. All odd numbers like 3,5,7 etc. are preferred by them, while all even numbers are considered inauspicious. They also mostly make houses of 5-7 *haath.*

While house construction practices being followed may be similar in both communities, the reasons and narrative are different. This is because of the different cultural narratives of the two communities. These communities preserve their identity by adhering to their community's beliefs with pride even while making decisions about house construction.

Cultural cognition, which is distributed across minds in a cultural group, plays a key role as the source of cross-cultural variations. Beliefs reflect the shared thinking of people and can be used to explore their thoughts and language. Knowledge creation amongst the community members in the Garhwal region is found to be intimately linked to their religious and cultural beliefs.

ECOLOGICAL SUSTAINABILITY AND KNOWLEDGE PRACTICES

By utilizing the abundant resources scattered in their surroundings, the people of the Garhwal region have demonstrated sustainability. While nature offers a wide range of resources, human beings have to devise ways to make the best out of it. The urge to sustain within their own region owing to various topographical reasons, perhaps was the motivational factor for the invention of *gharaat* by the mountain folk. They not only made maximum utilization of the water supply in their region but in the process created a masterpiece called *gharaat* without an effective substitute.

The various discourses villagers engage in reflect the traditional wisdom which goes in the construction and operation of a *gharaat*. While the creator of the *gharaat* remains unknown, it is clear that true scientific fervour was applied in its creation.

The making and maintenance of a *gharaat* is very systematic and scientific. The law of conservation of energy is clearly applied to transform the kinetic energy of a moving water body into mechanical energy, which is used to move the machine/turbine. The force of kinetic energy is directly proportional to the height and mass of the falling water, and therefore requires a continuous water supply. The rivers and streams in the region determine whether *gharaat* can be constructed. The greater the height of the waterfall, the more energy created; as such, the height of the *patnala*/tubular passage is 8-9 *haath*.

The villagers were confident in their methods which helped them co-exist with their environment. However, while no one could elaborate when, where, or who invented these methods, they agree on their ingenuity for having the local available water resources to such efficient use. Today the villagers are modifying this piece of available knowledge as per their need and convenience; however, the basic function and operation remains the same.

KNOWLEDGE OF LOCAL MATERIAL AND THEIR SCIENTIFIC USE

A specific quality of stone is used in a *gharaat.* It is a pale blue coloured stone known for its sturdiness, most commonly found in the rivers. Extreme care is taken to not choose soft stones because they are likely to break easily and are unsuitable for the purpose of grinding grains. The choice of appropriate stone for the *gharaat* is made during the cutting of the stone.

In the past, many non-governmental organisations have introduced modern techniques to aid villagers in their daily work. However, most of them did not transfer well owing to the fact that they did not evolve in the context of the communities' settings while keeping the various background factors in consideration. In villages, work is performed with a different mindset. The villagers have access to limited resources, and must sustain themselves whilst being mindful of their surroundings. Hence, their approach is to make the best out of available resources without depending on external assistance. For instance, villages make use of a lot of wood in their activities since it is fairly abundant. Wood can also be cut and shaped easily and conveniently. This is not in the case with iron and other metals, for which they rely on skilled individuals called '*lohars*' and their special tools.

CULTURAL IDENTITY AND THE FEELING OF 'WE' IN KNOWLEDGE CONSTRUCTION

It was intriguing for the researcher to find out that the villagers had a deep sense of pride in 'my culture'. Talking to them on a variety of issues, be it hygiene, sowing seeds, making tools, constructing houses, or the way they play hosts to guests, everything is clearly depicted as cultural identifiers which differentiates them from others. With limited resources, their endeavour is to maintain sustainability in the best possible manner. Abundant natural resource of wood is used extensively by the villagers in construction of houses or making the

tools. They can work with wood conveniently by themselves as compared to iron and other metals for which they have to rely on special people 'lohars' and their special tools. The belief in mutual cooperation is high amongst the villagers so as to achieve sustainability within the community. Except for the rarest of commodity they prefer to adopt a sustainable lifestyle.

IMPLICATIONS OF THE STUDY

PRESERVATION OF TRADITIONAL KNOWLEDGE SYSTEM

Situated in the central Himalayan region, Uttarakhand is a hub of biodiversity. The inhabitants of this hill state are a rich source of information concerning architecture, agriculture, ethno –botany, and ethno-medicine. Local inhabitants also cultivate less known crops and medicinal plants. The knowledge and biodiversity hold immense value for geneticists, medical practitioners, and academicians looking into sustainability.

Traditional knowledge systems were passed on through an oral tradition over the centuries, often communicating information through legends and myths. These systems and the evolution of knowledge must be documented so that they can benefit everyone else. Appropriately using traditional knowledge and technologies can potentially transform the socio-economic circumstances of the region.

By utilizing the abundant resources - both material and discursive - in their surroundings, the people in Uttarakhand demonstrate sustainability. Nature bestows a wide variety of resources in our surroundings. The villagers' need to sustain themselves irrespective of topographical concerns was perhaps the motivation behind the creation of the *gharaat*. They utilized the abundant water supply in the region by creating relevant technological applications that are useful even today. As such, schools should develop

interactive texts related to the *gharaat,* discussing various scientific concepts involved in its making.

A traditional knowledge system is the result of the process of understanding nature and its resources, and interacting with it in order to solve one's problems. Over a period of time, these systems have resulted in products and practices that are based on sound scientific principles, despite being informal and indigenous in appearance. We all need to understand and acknowledge that indigenous knowledge is a form of science.

The knowledge base, which guides the everyday life of the inhabitants, is based on fundamental popular pragmatism. It did not arise from discrete inspiration, but continuous sessions of interactions were involved in shaping them. Therefore, the introduction of any new policies in the area of education, agriculture, housing etc. should essentially be grounded in the local knowledge base to render them more suitable for inhabitants. This is so because local villagers understand this form of knowledge the best. Something that is better understood via their own terms, ideas, and values is more easily acceptable to them than the modern scientific ideas that must as well be Greek to them.

On observation, it was found that the Garhwali and Jaunsari villagers do not have an absolute form of knowledge. Their knowledge system continuously evolves according to their needs and the prevailing surrounding conditions; hence, some variations can be observed in their cultural practices as well as dialect based on the location. The folk knowledge system of the villagers in Garhwal region serves its purpose in an economically viable manner as compared to modern technological advancements, which are reliant on a more unconditional access to necessary resources.

Hundreds of years of experience of the community are seen in their everyday practice such as terrace farmlands, construction of houses with sloped roofs, use of *pathaals* in roof

making, and so on. The people in traditional communities have their own indigenous ways of estimation and measurement, which help them in making accurate judgements during their daily activities. Our present school system does not recognise traditional knowledge as valid owing to its informal and undocumented nature. The children in the village under study spoke to the researcher about the scientific and mathematical concepts taught in school, but were unable to connect them to practical applications in their everyday activities.

The pressure of learning scientific jargon has long been a topic of debate in the academic arena. Words are important in science as we have a specific terminology for all scientific processes. We rely on a combination and interaction of words, pictures, diagrams, images etc. while referring to scientific phenomena. Previous studies have repeatedly emphasized the need to carefully consider the content and language of textbooks. An inadequate textbook can be incomprehensible for learners, possibly demoralising them in their quest for knowledge acquisition.

Education has the power to remedy the numerous inequalities that exist in society. The New Education policy passed by the government in 2020 emphasises conceptual understanding, critical thinking, creativity, and innovation amongst students. A multidisciplinary approach to education is the need of the hour in order to cultivate life skills amongst our youth and enable them to think logically and innovatively.

There is an ardent need to preserve these enriching indigenous forms of knowledge and apply them in our teaching practices. The sense of familiarity people share with such knowledge will surely assist in their learning of modern science and measurement.

CURRICULUM FRAMEWORK

In the Garhwal region, the children involved in the daily activities spoke to the researcher about the scientific concepts introduced to them in school. They were unable to explain the logic behind their traditional practices, scientifically. They were aware of what a *gharaat* is and what it was used for. However, the underlying scientific terminology of concepts involved in the functioning of *gharaat* was not unknown to them. They could recite the definition of several concepts, but were not able to elaborate on them to explain various life activities. Therefore, the researcher intervened and explained the scientific concepts involved in these processes to the children. They were excited to understand and interpret their local everyday practices in a more logical and scientific manner. The traditional knowledge systems, which were passed on orally across generations through legends and narrations, need to be protected and revived so that our future generations feel proud of their culture and practices.

Meanings form the most fundamental aspect of a human social setting. They are created by our active mind in its interactions with the outside world. Basically, they are constructions of the human mind to explain its interactions with the surroundings. Language plays a very important role in the process of learning as a mediator of social and individual functioning (Kozulin,1990; Shepardson,1999). The sense of belonging and pride arising from one's own culture makes the children confident in creating meaningful concepts.

Education provides the means and opportunities to enhance a child's ability to creatively and aesthetically express themselves. Learning to learn and the willingness to unlearn and relearn are very crucial ways to react to life situations in a coherent fashion. As such, education must help develop these abilities to allow individuals to participate in economic processes and social change. This necessitates the integration of work with education, an

important part of the New Education Policy 2020 which advocates the integration of essential subjects for teaching life skills into the curriculum.

The induction of indigenous knowledge and themes into the curriculum will give students a better understanding of sustainable scientific concepts and enable them to appreciate scientific and technological concepts embedded in their everyday activities. Furthermore, this understanding will allow them to feel pride in their culture and traditions. China has already taken a step in this direction; their government is supporting the development of both western and traditional forms of medicine in their healthcare system under a common name 'Integrative Medicine.'

A Science programme which includes indigenous knowledge alongside western science will allow students to analyse two forms of knowledge (Jegede and Aikenhead (1999). The South African educational system has included indigenous knowledge in educational curriculum, confirming its efficacy (Department of Education, 2003). The learners, through this integrated learning process, get to connect the traditional knowledge with the formal school knowledge; one that they already know and the one they want to know. They learn to make a connection between indigenous knowledge, life experiences, and scholastic experiences, a crucial prerequisite for successful learning.

Why do we need a standardised scientific system which is universal in nature? The credibility or applicability of a scientific system is not dependent on it being universally acceptable. Rather it lies in the culture where it originated and developed because it is where its practical applications have been providing solutions from generation to generation.

CLASSROOM PEDAGOGY

Classroom pedagogy will take a positive turn as the integration of indigenous knowledge implies a more student-friendly approach. We need to free ourselves from the farcical bubble we have created for ourselves in the name of Universal Curriculum. Our schools offer education by a systematic repetition/memorising of scientific concepts and theories with no connection to real-world application.

The thought process of the natives in the Uttarakhand region is socially constructed, guided by the wisdom passed on to them across generations by their elders, collected in their quest to find solutions to various life problems. Cultural artifacts like tools, equipment, and various words/symbols all mediate in the development of higher mental processes amongst the villagers. Eventually, explaining all these activities leads to the development of inner processes and belief systems in individuals.

Meaning making or construction of thoughts is a continuous process that takes place among human beings. Society provides the physical framework, while culture offers rules and guidelines to operate in specific societal systems. The child at home grows up witnessing various practices being undertaken, and imbibes different words and symbols being used by the elders. Most learning occurs in a guided form where children simply follow the instructions of the elders; there is little offered in the form of scientific explanations. In their pursuit of finding solutions, they use culturally transmitted knowledge learnt at home to eventually form universally true concepts.

The existing wide gap between traditional everyday life activities and classroom teaching practices is largely responsible for making the learning process more of a burden for learners. Acknowledging traditional knowledge systems will allow the classroom atmosphere

to become more interactive and productive, motivating children to actively participate in classroom activities. Taking an ecological perspective will encourage the consideration of a wide range of possible ways to intervene, adopt instruction, and respond flexibly to each child's social, emotional, and intellectual needs in a holistic form of development.

The transmission of knowledge and skill development in the Garhwali and Jaunsari community takes place through experience and practical learning. Interviews with the villagers showed that the children or novices have to pass through a series of stages before getting formally inducted into the primary workforce. When students study local materials and practices as an example in classroom learning, they are motivated to create their own ideas by looking at a problem and formulating their own practical solutions. Making our classroom teaching more learner-centric and contextual is the call of the hour; such an approach would imply integrating indigenous knowledge effectively and teaching science in a more meaningful way.In classroom situation, educators can take up the role of learners while the student gains the confidence to exhibit his/her traditional knowledge and wisdom.

The recognition of indigenous knowledge will also have major implications in framing policies of social and economic purposes since the newfound perspective provides a much deeper and broader understanding of the situation. Developing critical thinking amongst students enhances scientific knowledge, imparts important life skills like money management, and allows the integration of practical life situations with the acquired scientific knowledge.

It is high time we change our approach to protect and preserve the highly endangered indigenous forms of knowledge across the world. Most such knowledge is not written or recorded formally in books. If we do not motivate new generations to feel proud of indigenous knowledge or wisdom, they will distance themselves from it. This will eventually lead to the

extinction of that form of knowledge and give way to generations of individuals ignorant of local wisdom, a phenomenon that is only becoming increasingly common today.

Education is not just literacy; textbooks are a means not an end; education is not just about getting a job - it is about being able to lead a happy and meaningful life. In many ways, contemporary education has limited people to a certain set of unquestionable assumptions. In the dominant world-view, there are only narrow definitions for 'development,' 'progress,' 'education, 'science', and 'modernity'.

The Indian education system is a legacy of colonial rule; its overall framework has remained the same even 60 years after independence. This system compels students to unthinkingly and unquestioningly accept the dominant world-view. It makes the youth dependent on the "other" for information, ideas, knowledge, understanding, and decisions. Such a "system" does not teach or encourage students to understand 'how' to think, but instructs them on 'what' to think. Such a ‘utilitarian’ approach to education only makes people literate and equips them with job-oriented skills. In contrast, the 'classical' view sees the role of education as the development of an individual beyond what is required for his civic or vocational role. It is extremely important to challenge reductive assumptions and definitions. Notions about who is 'civilised', who is 'backward', or what is 'scientific' need to be viewed afresh. It is only then that we can have a realistic perspective of our society and its knowledge systems. Education should not only help an individual acquire knowledge about self, society, and environment; it should also help him or her to lead a happy and content life. There are many people, thinkers and activists who are trying to bring about fundamental changes in the education system.

The innate knowledge in a child is dynamic in nature. The learning of a child, mediated by school instruction, is majorly responsible for the development of higher mental processes.

This type of learning is most permanent provided the instructions are given in an organised manner, which the child is able to connect with the previous knowledge learnt at home. Spontaneous learning or innate knowledge is already present within a child. By observing the elders, a child tries to derive conclusions about processes and tries to use related concepts in other life situations. Here, the need arises to instruct them in an organised manner so that spontaneous learning acquires a 'scientific' nature. This scientific knowledge provides the base for the development of higher mental processes in children.

Mostly our scholastic education results in empirical or rote learning, where the student is made to memorise the verbal definition of a scientific concept without understanding it. However, this mode of instruction holds a very important position in scholastic learning. In such scenarios, instructors must be aware of what children must learn in the classroom. Do we want them to become just another bunch of obedient learners who want to just lead a non-enterprising life without questioning their routines? Such education does not provide the necessary insight to students for creating new innovative ideas.

One very important point the researcher came across while performing the study is that there is no dearth of potential resources, talent etc. in the hilly region. The Jaunpur area - which comes under the backward region of the state of Uttarakhand – has ample food supplies for the people to sustain themselves. People want their children to learn and get educated, which is why they send them to school. Interactions with villagers revealed that children travel for 10-15 kms daily to reach the school. In these hilly areas, it is not uncommon to see even very young children fetch water from a faraway source, collect firewood, and fulfil other responsibilities in schools by the teachers under the pretext of the government mid-day meal scheme. This results in the loss of precious time meant for learning and gaining knowledge. They slog hard for some years in this system, and when they are not able to sustain this lifestyle,

most of them remain a backbencher in the classroom or drop out, opting to leave the region for better education opportunities in the cities. With their move, we lose more young, enthusiastic minds which could have aided in the growth of the community and in conserving and enhancing cultural heritage.

LIMITATIONS OF THE STUDY

The present study does not claim to have explored all everyday activities of the Garhwali and Jaunsari villagers. Only some activities could be explored for discovering the embedded scientific concepts. The study manages to fulfil its purpose satisfactorily within the contextual limits. The findings can be of immense use to future researchers in the field of education and cognitive development, which attempts to study knowledge as a social construct.

The question which now crops up is, if the informal traditional knowledge system is so valuable, why does it remain unincorporated in our teaching practices? Keeping in mind the importance of situated cognition, as inferred by the review of aforementioned studies, traditional knowledge should have been an integral part of our school system. In reality, this is not the case. By ignoring it, it could be argued that the current education system is a farcical one which does not fulfil its goal of providing comprehensive and applied knowledge

It is high time that communities and nations find pride in their indigenous scientific expertise and make it mainstream by investing resources and manpower, thus expanding the base of training and education in traditional knowledge systems. For this, governments and policy makers must consider revising the constricted approach which considers Western science as the only form of verified and accepted form. This step will not only help neutralise biases against indigenous knowledge, but will also motivate their inclusion in future official policies.

By understanding the cultural differences and behaving sensitively, both teachers and students can work together to seek new ideas and possibilities in classroom learning. Culture-based learning will definitely make individuals more confident about their knowledge, equipping them to face life's challenges using a more critical approach.

In subsistence economies, socialisation plays an important role in achieving the goals of survival and sustenance. The prevalent cultural practices in the Garhwali and Jaunsari communities provide ample support to this belief. The barter system, house building practices, the *gharaat*, and local measuring units are all testimonies to that fact.

Integration of Indigenous knowledge system in the education system does not intend to uproot or abandon the formal science, experiments, objectivity or the universal laws of the idea of infallible science. Rather, its motive is to come up with a scientific approach that has its roots firmly grounded in a rich and descriptive understanding of inhabitants. The idea is to make science more usable and empirically verifiable, eventually using it for problem-solving in practical situations. Science must not be confined to mere theoretical classroom instruction.

DIRECTIONS FOR FUTURE RESEARCH

Future research in this area can address a variety of aspects which could not be elaborated upon because of multiple constraints such as the specific objective of the study and the paucity of time. The learners need to be probed in the school environment in order to ascertain how they engage in scientific discourses in the class, and how they incorporate everyday concepts in solving these problems. Future studies can focus on how teachers plan lessons and design teaching approaches which are best suited to make the classroom learning more student centric. Researchers can also inquire as to how curriculum can be made more

learner-friendly to promote better understanding amongst teachers at both the conceptual and epistemological level.

There is an ardent need for us to adopt a broader perspective when engaging in science; innovative and learner-friendly teaching strategies must be devised in the classroom such that indigenous knowledge is integrated into it. Keeping in mind the socio-cultural nature of science and technology will motivate us to appreciate its inclusion in our classrooms.

Some issues like how learning takes place in the school system, grade retention, dropping out, etc. can be studied, with studies focused on comparative studies amongst the communities found in the region.

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