CHAPTER – 7

Mathematical principles in ordinary life

In this section an effort will be made to show that how mathematical principles regulate the life of an ordinary human being, particularly to the villagers. The mathematical sense of them was so prominent that they formulate a peculiar formūla to indicate something else. In fact, they are habituated in using a mathematical phrase on a mathematical code to describe something, which is very difficult to express in ordinary non-mathematical language. Sometimes mathematical principles serve the purpose of artistic expressions, which are normally done by the villagers. A particular number may be seen to be similar with the name of someone's dear one. If he or she wants to express it artistically, he or she will take recourse to the numbers or addition or multiplication of some numbers, the result of which is phonetically similar to his/her wife's or husband's name. Particularly among the villagers and tribal people such techniques taken from mathematics are normally used as modes of expression.

A fairly discernible trend in any venture seeking mathematical traditions in the Indian context seems to be obsessed with the contributions of great celebrities of mathematics in those days. It is uncriticality in such studies that hardly enables anybody to get at the evolution of mathematical thinking or ideas in periods of antiquity. This apparent lack of linkage, often blurred by religious beliefs, between different types of pursuits, doubtless, make such studies vulnerable to a total view which reckons necessarily societal, cultural, historical and, in some sense, philosophical underpinnings. On the other hand, a discipline like mathematics did not have, to speak in modern idioms, elitist adherents only but also practitioners of mathematics, to use modern jargon, at the grass root level. Extant studies on mathematical traditions in India have, by and large,

identified areas of pursuits associated with dominantly theoretical studies but not specifically those out of which mathematics can emerge somewhat organically as a discipline oriented activity.

A cultural vis-à-vis anthropological view of mathematics or strictly speaking, mathematical way of thinking becomes a necessity and hence, some examples in the Indian context drawn from folk wisdom and practices are set forth. Next, we delve into conceptual issues on ethno mathematics and its possible offshoots. Environment can hardly be ignored in such contexts and hence, the linkage between ethno mathematics and environment is brought out. Following this, we swing back to the consideration of cultural vis-à-vis anthropological dimensions of mathematics. A matrix model is made use of to bring out relational features between entries on mathematics and those on cultural dynamics.

In the succeeding section, philosophical view of ethno mathematics is considered. Some remarks, as a part of winding up, are made in the context of a wider need for developing or perhaps, identifying an integrated trajectory of mathematical thinking against the backdrop of the vast landscape intermingling society, culture, philosophy, history, ethos and mathematics.

ETHNO MATHEMATICS : CONCEPT OF D'AMBROSIO

The image of mathematics that has come to stay is one of abstraction divorced from realities, but at the same, one that caters to usages of a diverse nature. The use of mathematics, for its own sake and for others, is being contested, and has remained within the confines of a select few; the bulk of society, as it were, is outside the group of the privileged few. This poses a threat to dynamics of culture and society. Hence, in a bid to set at nought possible disruption of societal equilibrium, there is now an effort to seek social and cultural roots of mathematics in the vast repository of human endeavour.

The shift in paradigm lies in looking at reality from the standpoint of 'perception' by individuals. Ubiratan D'Ambrosio, the architect of this view, has proposed a model of human endeavour which has connectivities, reality-individual-action-reality, obviously a cycle, as characteristic of human individuals, see, D'Ambrosio.[1] This does not run counter to hierarchial order of human endeavour, which allows the flow from individuals to collective (or social) to cultural behaviour and ultimately, to cultural dynamics. Knowledge fits in as action in the framework of cyclic model and this allows human endeavour to move from one level to another. The basic assumption, here, is action inherent in individuals, whatever be the dimensions. Action keeps on recasting the reality, which may be material; or may be purely a cognitive (intellectual, psychic and emotional) reality.

The concept of knowledge emerges properly if we look deep into several cultural contexts. Knowledge, in such contexts, does not make a distinction between actions to understand and to create and hence, science and technology, as they are understood, are well reckoned. The complementarities of science and artistic activities are also well assured.

The reality, as mentioned earlier, is taken to have essentially two dimensions; namely, environmental (including natural and artificial) and intellectual (emotional, psychic, cognitive) which constitute the intrinsic and intimate abstract reality of ideas. Thoughts then become part of the reality-affecting individuals along with their emotions. Reality is obviously social and hence, one has to accept the possibility of interconnectivities between environmental, abstract and social entities.

D'Ambrosio[2] builds up the concept of society out of cultural attitudes and diversities so that different groups of individuals behave in a similar way, on account of their modes of thought, interests, motivations, often myths etc. Societal groups exist with clearly defined cultural roots, modes of production, class structure, class conflicts, individual rights etc. Such groups develop, over the centuries, ways to count, to measure, relate and classify or in other words, ways to mathematize. These are in many ways different

from the ways, which are done by other cultural groups. The question that now comes up is this: how do we relate mathematics with culture? What kind of culture is this? What kind of mathematics is this?

By culture, we ought to understand something that is added to the world as a result of human labour, creativity of an endeavour for survival; it becomes thus an acquisition to be shared and nurtured by (cultural) groups. The structured form of knowledge; it precedes all forms of scientific understanding of the world through recorded repository of endeavour of all civilizations.

The word *ethno mathematics* is used in such contexts, because the word *ethnos* has come to connote race/culture, necessarily implying specific cultural racial codes, symbols, values, attitudes and so on. D'Ambrosio succinctly puts this as:

Ethno mathematics is a concept resulting from perception of man as an animal in search of survival and continuation of species but with a plus over the other animal species. This plusis the drive to transcend one's won existence (the sense of the past and future, sense of religion and art, sense of explaining and understanding) and to transcend, by giving to it and extra dimension, the search for survival and procreation, which is *Homo Sapiens*, results from a different perception of the other, giving rise to senses of love, shareability, generosity, charity and the like. We prefer to call *mathema* the action of explaining and understanding in order to transcend and of managing and coping with reality in order to survive. Throughout all known life histories and throughout the history of mankind, *technes* (or tics) of mathematics have been developed in very different and diversified cultural environments i.e., in diverse *ethnos*. So, in order to satisfy drives towards survival and transcendence, human beings have developed and continue to develop in every new experience and in diverse cultural environments, their ethno mathematics. These are communicated vertically and horizontally in time and for the reason of being more or less effective, more or less potent and sometimes even for political reasons, these various tics have either lasted and spread (i.e., measuring) or confined themselves to restricted groups and even disappeared.[3]

According to him, ethno mathematics depends on new understanding of history and epistemology, 'essentially a new way of looking into the process of generation, transmission institutionalisation and diffusion of knowledge', see, D'Ambrosio.[4]

This approach should make us think afresh, particularly in relation to human understanding and creativity, whether there are socio-emotional and political elements and, perhaps, many more, which we know as arts, science, religion, culture etc. We should also make an effort to verify whether there was any semblance of historical entity or even existential entity, before such levels were designated. These ideas inevitably give rise to theoretical concerns as a part of the explanation of nature as a whole and of human endeavour in the environment. Human beings have intrinsic but unique characteristics of codifying and symbolizing these practices as a means for survival and then going beyond this, that is, to transcend. There does not seem to be any dearth of endeavour through cultural environments to explore the body-physique and its ailments, strengths, weaknesses etc. and there is a greater realization now than what it was ever before, see, Horacio.[5] The history of development of mathematical ideas show, in very succinct terms, evolution of the concept of time and also its importance. Even while going to the other extreme, one finds a counterpart in rural but culturally vibrant setting. For example, in Tamilnadu, vide, L.S. Saraswati,[6] the concern was to identify and measure time with, of course, the ulterior objective of performing some activities, mainly agricultural and, perhaps, some rituals of religion. D'Ambrosio draws upon this as follows:

What they do for reckoning time is to use a simple device for measuring shadow. They take a piece of straw of any length and divide it into sixteen equal parts by folding it in half, eight times. The straw is then bent like an 'L' and held on the ground with the vertical portion towards the sun, so that shadow of the upright portion falls on the horizontal portion kept on the ground. The vertical portion is adjusted in such a way that the length of its shadow is equivalent to the length of the horizontal portion. In this way the number of parts of the upright portion indicate the number of units of time that have passed since sunrise if it is forenoon or the number that have passed since noon if it is

the afternoon. People in this community are reported to tell time and to reckon with the precision of minute.

One finds in human endeavour the kind of cycle, already mentioned, namely, 'reality-individual-actual-reality'. Thus, in terms of D'Ambrosian framework of ethno mathematics, the population of Tamilnadu has developed tics (technes) of *mathema* (action of explaining and understanding in order to cope with reality and, perhaps, to transcend). One can cite a host of such tics of *mathema* in wide and diverse cultural environment that is what D'Ambrosio calls diverse *ethnos*.

Ethno mathematics has, thus, come to stay as a concept that allows generation, transmission and diffusion of knowledge with an accent on socio-cultural environment. It is not just rituals or daily mundane activities that show semblances of mathematical enterprises. There is in *situ* reality of mathematical exercises well reflected through folk-culture, folk-lore, folk-rhymes, folk-proverbs, folk-riddles and folk-wisdom, see, Bhaumik and Sinha.[7] Let us now cite a few of them, as they occur in a dominantly Bengali setting.

We begin with few cases that appear as a part of folk-practice and folklore. The first one is about the number 'sixty' whose Bengali variant in a dialect is *shait*, as it is pronounced.

A Bengali tribal woman, who is not allowed to take her husband's name, in order to provide the name of her husband, puts it as follows:

Tin tero diyā bāro
Noi diyā milāni karo
Mor soāmir nāmti aei
Pār kore dāo bārit jai

This means: if you; multiply the number 'three' by 'thirteen' and add 'twelve' and 'nine' with the result, you see the answer is simply 'shait' i.e. sixty. Here the numerals

tin (three), *tero* (thirteen), *bāro* (twelve), *noi* (nine) are used. And the number *shait* (sixty) comes out of the mathematical operation (i.e., 3x13+12+9=60).

There goes a similar riddle: 'Panchanan' is the other name of the God Siva, the husband of the Goddess Pārvatī. There runs a beautiful mathematical verse commented with the name of 'Panchanan'.

Tin tero madhye bāro
Chār diā puran karo
Āmār bāri nandigram
Aei āmār swāmir nām

If one multiplies 'three' with 'thirteen' and adds 'twelve' plus 'four' with the result, one gets the number 'fifty five' which corresponds to the Bengali version 'Panchanan'. Thus originates the name 'Panchanan'. In accordance with the accepted condition, the problem may be posed as follows: (3x13+12+4=55). All these show how the community can handle computational or operational exercises on numbers.

The following example, again, will reflect the concern for numeracy. While playing together in the field, farmer's boys count the number of players among themselves by reciting very interesting and peculiar rhymes, each word of which represents a particular number. For example,

Yākor byākor tyākor shāil
Kāil porshu Mongol bār
Kāri gone majumdār
Dhāner āgā nāler shish
Khāiā doba unish bish

Here the word *yākor* represents the number one, *byākor* two, *tyākor* three, *shāil* four, *kāil* five, *porshu* six, *mongol* seven, *bār* eight, *kāri* nine, *gone* ten, *majum* eleven, *dār*

twelve, *dhāner* thirteen, *āgā* fourteen, *nāler* fifteen, *shish* sixteen, *khāiā* seventeen, *doba* eighteen, *unish* nineteen, *bish* twenty. Thus they are able to count all the numerals from one to twenty.

A few more examples regarding numbers may be given here.

Śunyo: The word śunyo implying mathematically 'zero' may be seen in the Bengali proverb: *Duṣṭa gorur cheye śunyo goal bhalo*

It is better to have an empty (*Śunyo*) cowshed than a notorious cow.

Rām: Ram stands for the number 'One' in some places of Bengal for weighing things.

Duna: It means *double*. There is a well-known proverb in Bengali.

This means, double-strength may be gained taking less diet whereas more food brings danger.

Dera: This means 'one and a half'. There is a saying (*Kame Kura Bhojae Dera*). This is about one idle person, which takes one, and half times of his normal food.

Punke: It is a fraction and is one-sixteenth part of the whole. In the proverb *Punke satru baro apod. Punke* stands for a small fractional quantity. A small enemy may sometimes be harmful.

Kara and gaṇḍā: One *kara* is one-twentieth part of a *paisa* and four *aras* make a *gaṇḍā*. A *gaṇḍā* is one fifth of a *paisa*. A *Bāul* song regarding this *kara* and *gaṇḍā* may be quoted here:

Amike tai ami janlem na
Ami ami kari kintu, ami amar thik hailo na
Karai karai kari gani
Char karai ek ganda gani
Kotha hoite elam ami, tare koi gani?

The central thought of the song that the Bāul sings is: 'I always keep account of my belongings but I have never tried to know myself'.

The following examples illustrate the use of terms for measuring the weights of things:

Poā: This is one-fourth of a *seer* and is an important unit of measurement of weight prevalent among the folk-life and culture. Four '*chhataks*' make a *poā*. A proverb regarding the *poā* goes like this:

Bhāt roche nā roche moā
Chria roche poā poā

This may be stated as follows: you don't like bread but you take delight in eating cakes and tasty crisps in *poās* (that is, in plenty).

Rek is equal to twenty '*chhataks*' and one-fourth of a *don*. A proverb associated with *rek* is as under:

Khābona khābona anichhey
Tin rek dāl ek uchhey

This means that even though I have no appetite, I may take three *rek dal*.

Ari is another unit in expressing the measurement of weight. The proverb connected with this is as follows:

Hā-bhāter ari āthāro seere

In fact, *ari* does not actually mean eighteen seers. One *ari* is equal to sixteen *seers*.

Here are some examples illustrating the use of shapes and sizes that are the basic rudiments of geometrical knowledge.

Ārāhi Penchi: It is an ornament with 'two and a half circles'. Its shape is pinpointed here in the following Bengali riddle.

Gol gol ārāhi penchi tār nām ki?

Sidha: It means straight. A well-known proverb in Bengali runs thus:

Sidhā āngule ghee othe nā

It is not possible to collect butter with a straight finger.

The conception of time is lying scattered in various folk-literature - in phrases, idioms, proverbs, lyrics and in all walks of rural life of Bengal. A proverb with time:

Samayer 'ek' phonr
Asamayer 'dash' phonr

The equivalent English proverb is 'a stitch in time saves nine'.

Prahar is an important unit in measuring time used by the villagers in their daily lives. This can be illustrated in the Bengali proverb:

Kukurer māār āarāi prahar

It means that the pangs of a dog do not last long and soon after, it responds to the person beating it. The inner significance of the proverb is that a shameless person commits the same nuisance after being insulted time and again. *Āarāi prahar* mentioned in the proverb signifies a very small period of time, as one *prahar* is one-eighth part of a day.

Thousands of such examples may be cited from the folk-practice and folk-culture.

All these are remarkable examples of ethno mathematics, which abounds in the community. If we look at them critically, we may be persuaded to a point of view that these stem form and, perhaps will continue to mark, the participation in what sometimes may be called ceaseless cultural dynamic.

SOCIAL AND CULTURAL FACETS

Given the premise that mathematics is a fairly deep-rooted element in the fabric of culture that keeps on flowing through the ages, we need to hark back to social and cultural history coupled with anthropology with a view to unearthing mathematical elements that have stood the test of time. By social history of mathematics, vide Mehrtens et al.,[8] one aims at understanding the interplay of socio-cultural, economic and political factors in the development of mathematics. There are few studies on this score, see Wilder,[9] Bhaumik and Sinha.[10] But that mathematics is embedded in cultural phenomena without members being aware of the same has been excellently brought out by Ascher.[11] One can cite a host of pedagogical studies which show, in an abundant measure, the mathematical stuff produced by many different historical cultures in their immense diversity, running to contemporary times, see, Ascher,[12] Frankestein,[13] Lave,[14] Millroy[15] and, certainly, Freire.[16] Of late, there is move to link up, in such contexts, cultural features and mathematical topics, in a one-to-one correspondence style. Rubenstein[17] attempts to develop a matrix in which there are entries for both the dimensions, cultural and mathematical. Indeed, cultural attributes are amenable to analysis in terms of few distinct categories, which/are, by no means, decisively comprehensive. For example, one can have categories with labels of languages, of history and geography, economics and politics, social aspects, aesthetics and recreation, see, Rubenstein;[18] it should be mentioned that the last five entries are side rubrics,

covering elements that may not be strictly distinguishable in few cases. But, by and large, customs, traditions, habitats etc. are well reckoned as social features while aesthetics have dominantly fine arts, performing arts, handicrafts etc. as the leading components. Mathematical entries can have wide extents and, sometimes, depths depending on levels of capabilities and competences. But, if we agree to basic rudiments of mathematics, we can possibly agree to categories such as communication; reasoning, number and numeration, measurement, patterns, functions, and algebra, geometry, statistics and probability, and discrete mathematics, see, Rubenstein.[19] All these are designed as 'eight by three' matrices. For example, in a row of language and a column with a number and numeration, one may have an entry relating to comparison of strength to people, animals and gods so as to build, in ancient India, powers of ten or in a row for geometry and column of social features, one may seek the way of structurally similar elements in Taj Mahal and so on. Essentially it comes to examining closely some leading strand of cultures and also in cultural phenomena, mathematical entities, as Ascher[20] has mentioned: 'how people categorize things is one of the major differences between one culture and another'. The matrix should be so designed as to begin with a cultural context and to extract as much of the possible mathematics from it as one may can. Thus the multicultural matrix becomes crucial to the process of generation, transmission, dissemination and, perhaps, institutionalisation of apparently naïve ideas in mathematico-cultural terms and relationships which, indeed, form the bedrock of ethno mathematics.

PHILOSOPHICAL VIEW

Having disposed of cultural and social aspects interspersed with historical elements, let us explore if there are philosophical underpinnings of ethno mathematics. The epistemological approach to mathematics is sufficiently well-known but that, too, in an ethno mathematical framework is yet to be conceptualised to a fairly acceptable degree.

Our starting point ought to be the human element, rather, a view of human beings which is so fundamental to the idea of ethno mathematics. Unless one sets up the linkages between the idea of ethno mathematics and a view how people relate to other human beings and to the world, one can hardly build up possible philosophical moorings of ethno mathematics.

Let us have (see, Borba)[21] the basic concept on the view of humans. There is the well-known phenomenological approach in which a human can only be seen in relation with the world and if there is no world, human is not visible. Thus, there is an intrinsic linkage between the concepts 'human' and 'world', with a serious limitation that both of them have or acquire meanings because of the humans. There is, of course, the fundamental relation of each human to other humans depending essentially on abilities to understand to comprehend existing implications and also to go well beyond extant nuances. It, therefore, boils down to the existence of the location in the world each person in definite historical situations. To live in a world, one has to undergo experiences often without being consciously aware of the element of time. Freire[22] makes positive distinctions between one kind of consciousness and the other. Mathematically speaking, a transitive consciousness develops in a person, the ability to reflect deeper on the experiences, at least to the extent of distinguishing the current ones with earlier counterparts. There is obviously an element of criticality in transitive consciousness. But, unless one crosses this hump, one can hardly be active so as to embark upon interactions with other persons, say, in the form of dialogues. This is precisely what has been called dialogical process. A coupling of the two is essential to the subsequent development processes of each human in relation to the other. One should hasten to add that in the dialogue, words are not only elements to be communicated but the very wide variety of unconscious signs and symbols such as pauses, gestures which may even baffle lexicographic storage. There is every eventuality that signs and symbols may evolve from one cultural group to another in their implications, meanings and interpretations. A necessary concomitant for the dialogue should share a common concern and a perception. In other words, the so-called

dialogue can hardly become a reality if there be no problems emanating out of the cross-fertilization of problems with different groups. According to Saviani : 'A problem, as any other aspect of human experience, has a subjective side and an objective one, closely connected by a dialectical unity.... The concept of problem implies a consciousness of a situation of necessity (subjective aspect) and a situation that puzzles his consciousness (objective aspect)'.[23]

Both the aspects, subjective and objective, of the definition of a problem have cultural limits, for these cannot but depend on cultural traditions of a person so much so that even the irritants having objective semblances are culturally bound, for the simple reason that an impediment in a given culture may not pose to be the same in another. Thus, one gets stuck and also grapples with it for own survival in the evolution of life-styles. A mathematical problem is bound to emerge because of this encounter and hence, the generation of mathematics. Language is definitely an important vehicle to express a way of knowing developed by a culturally sensitive group of human beings. If we accept that one way of knowing is mathematics, then according to Borba,[24] mathematical knowledge 'expressed in the language code of a given socio-cultural groups' should be termed ethno mathematics, with connotations for ethno mathematics set forth earlier.

CONCLUDING REMARKS

It should not be taken for granted that ethno mathematics as a distinctive area of pursuits has gone totally unscathed. The bulk of such exercises have ranged heavily on educational enterprises perhaps, often slurring over conceptual shortcomings. While the cultural context as a central theme is undeniably important, there is scepticism as to the intrinsic characteristics of ethno mathematics to be able to be transformed to the nature of mathematics which is dominantly intellectual. The social institution of mathematics which sociologists, historians and others pursue as an important area of investigation can hardly be glossed over.

Cobb[25] has looked upon ethno mathematics as self-generated mathematics, which as argued, is basically individualistic and anarchistic. Ethno mathematics, it is often alleged, addresses the question of how context affects and structures experience. There is an element of substance in the unassailable statement that mathematics which we do not directly experience can still have important consequences having direct impact on our life-styles. Critical thinking stems out of confrontation with problems as described above. Once critical thinking acquires a certain measure of communality in respect of sharing problems, 'self-generated mathematics' of Cobb should be inevitable to ensue. Mellin-Olsen[26] has gone to the extent of drawing upon the Freirian concept of 'conscientization' in that the people are made aware of their culture how their experiences are structured and conditioned. One may look for conceptual underpinnings of how the ethno mathematics produced could be affected by techniques, be made available and the value adopted by the social institutions of mathematics. One can even move on a bit of micro-level analysis so as to investigate that if structures of mathematical experiences have any influence on the generation of ethno mathematics, taking into account that these forms, basically part of subcultures and mathematical resources. This may be logically pushed to a conclusion that ethno mathematics can

facilitate structuring of mathematical experiences of those outside the subculture which have generated it; but of course, that can again be the role of ethno mathematics once it gets a solid footing.

Ethno mathematics puts the accent on plurality of mathematics rather than a monocultural phenomenon. It often rakes up the notion that mathematics is only produced by mathematicians. It enables us to look for ways in which one can understand cultural ways of producing and expressing their mathematics. That there can be indigenous 'frozen' mathematics in diverse cultures of the country hardly requires any reiteration. The indigenous wisdom, if it is a correct term in the context of the International Year for Indigenous Populations (1993), provides the vast repository of ethno mathematical and ethno scientific concepts and ideas which need to be articulated as inter-connectivities discernible in the landscape of mathematical endeavours.

The Advaita Vedāntins have used a sentence 'daśamastvamasi' (i.e., you are the tenth) to explain the phenomenon of perception generated through testimony called *śābdajanyapratyakṣa*. An individual who is really tenth but did not count himself out of ignorance. When it is pointed out whether he has not counted himself and he is the tenth, he suddenly realises that he is a member occupying the number of 'ten'. This realisation is direct perception generated through testimony. In such cases the philosophers of different schools have used number to indicate a fact or person.

NOTES AND REFERENCES

1. U.D'Ambrosio, *Socio-Cultural Bases for Mathematics Education*, Unicamp, 1985; *Ethno matematica, Raizes Socio-Culturals da Arte On Tecnica de Explicare Conhecer* (a collection of six essays), Unicamp, Campinas, 1987; 'Ethno mathematics and its Place in the History and Pedagogy of Mathematics'. *For the Learning of Mathematics*, 5. 1, 1986, pp. 44-48.

2. U.D'Ambrosio, *Ethno matematica, Raizes Socio-Culturais da Arte on Tecnica de Explicare Conhecer*, 'Ethno mathematics and its Place in the History and Pedagogy of Mathematics'.

3. U.D'Ambrosio, '*Ethno mathematics and its Place in the History and Pedagogy of Mathematics*'.

4. Ibid.

5. Fabrega Horacio Jr., '*The Need for an Ethno medical Science*', Science, 189, 19 September 1975, pp. 969-75.

6. L.S.Saraswati, *Functional Approach to Women's Literacy, Problems of Women's Literacy*, Central Institute of Indian Languages, Mysore, 1979, pp. 13-32.

7. A.Bhaumik and D.K.Sinha, '*Mathematics Education for Indigenous people:Ethno mathematical Point of View*', presented at First Indian Congress on Mathematics Education, Calcutta, 1993.

8. h. Mehrtens et al. (eds.), *Social History of Nineteenth Century Mathematics*, Brikhause/Boston Basel/Stuttgart., 1981.

9. R. Wilder, *Mathematics as a Cultural System*, Pergamon Press, New York, 1981.

10. Bhaumik and Sinha, '*Mathematics Education for Indigenous People*', (Same Edition).

11. Mascher, *Mathematical Ideas in Non-Western Cultures, Historia Mathem*, 1984; Ethno mathematics : *A Multicultural View of Mathematical Ideas*, Brooks/Cole, Belmont, California, 1991.

12. M. Ascher. *Ethno mathematics : A Multicultural View of Mathematical Ideas.*

13. M.Frankestein and A. Powell, *Toward Anti-Domination Mathematics : Paulo Freire's A Critical Encounter*, edited by P. McLaren and P.Leonard, Routledge, New York.

14. J. Lave, *Cognition in Practice*, Cambridge/England, 1988.

15. W.Millroy, '*An Ethno graphic Study of the Mathematical Ideas of a Group of Carpenters*', Ph.D. thesis, Cornell University, 1990.

16. P.Freire, *Pedngogy of the Oppressed*, Penguin Books, Harmondsworth, 1972.

17. Rheta N. Rubenstein, '*A Multicultural Matrix for Mathematics Education*,' University of Windsor.

18. Ibid.

19. Ibid.

20. M. Ascher, *Mathematical Ideas in Non-Western Cultures.*

21. M.C. Borba, '*Ethno mathematics and Education*', For the Learning of Mathematics, 10 (1), 1990, pp. 39-43.

22. P. Freire, *Pedagogy of the Oppressed.*

23. D.Saviani, *Do Senso Comum a Consciencia Filosofica*, Cortez, Editora, Sao Paulo, Brazil, 1985.

24. M.C. Borba, '*Ethno mathematics and Education*'.

25. P.Cobb, '*Contexts, Goals, Beliefs and Learning Mathematics*', For the Learning of Mathematics, 5. 1, 1986, pp. 44-48.

26. M.J. Hoines and S.Mellin-Olsen (eds.), *Mathematics and Culture*, Casper, Forlag, Bergen, 1990.