MY JOURNEY OF LEARNING AND TEACHING MATHEMATICS FROM TRADITIOINALISM TO CONSTRUCTIVISM: A PORTRAYAL OF PEDAGOGIC METAMORPHOSIS

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AN ABSTRACT OF THE DISSERTATION OF

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Abstract approved _____

Mr. Bal Chandra Luitel, Dissertation Advisor

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Dr. Peter Charles Taylor, Dissertation Advisor

This dissertation depicts my paradigmatic shift from traditionalist approach to constructivist approach of teaching and learning of mathematics. I have used autoethnography as the genre of writing and research that connects the personal to the cultural placing the self within a social context (Reed-Danahay, 1997). Employing autoethnography, I have studied my experiences as a mathematics learner, teacher, educator and researcher and how these informed my pedagogical practices and knowledge as a school teacher and an educator. As an Autoethnographer, I have presented my work in alternative textual forms such as layered accounts (Ellis & Bochner, 2000) with four criteria of writing – orientation, strength, depth, and richness (Van Manen, 1988) – to create pedagogical thoughtfulness and pedagogical wakefulness among the readers (Luitel & Taylor, 2003). I performed my narratives as

poems, drama, dialogue, and stories (Denzin and Lincoln, 2005). I have mentioned about triple crises, a triple threat, a triple crown of thorns: representation, legitimation and praxis in the research (Denzin & Lincoln, 2005). I have also informed the research process and product with the rigor criteria.

This study changed my belief about what is reality (ontology), my view on how to know the reality (epistemology) and accordingly what ways to adopt in order to make students understand the reality (pedagogy). My reflections and review of literatures formed the ground to change my ontological assumptions. Multilayered analytical and interpretive autoethnography in my cultural context enlightened me of what is knowledge and how knowledge is acquired. Evolution of teaching methodology from beginning of my teaching career to till the date I joined School of Education, Kathmandu University depicts layered and staged pedagogical metamorphosis

In brief, this study depicts how a conventional learner, teacher and educator turns into a transformative educator and researcher through self reflection and confession on wrong practices. and envisioning the better methods of teaching and learning

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Shashidhar Belbase Date

DEDICATION

This dissertation is dedicated to Late Ryutaro Hashimoto who provided Hashimoto Scholarship through Hashimoto Foundation Japan for my M. Phil. Study.

DECLARATION

I here by declare that this thesis has not been submitted for candidatature for any other degree.

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Shashidhar Belbase Date:

Master of Philosophy in Education dissertation of Shashidhar Belbase presented on July 21, 2006.

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I understand that my dissertation will become a part of the permanent collection of Katmandu university Liberary.My signature below authorizes release of my dissertation to any reader upon request for scholarly purposes.

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Shashidhar Belbase Date:

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Shashidhar Belbase Date

TABLE OF CONTENTS

PROLOGUE

My Brief Journey of Education

Born in the small village of Piparkhutti, Deukhuri- Dang, Nepal in 1972, my childhood passes with joyful play and moments of happiness with my parents. I remember playing *chari, chharra, khopi, topiluka* and *lukamari* with friends. *Kapardi, bhalejudhai, bagchal* and *ghuchchi* are interesting games for me. These games and play lay strong impression in the young mind about logic, number sense, patterns and shapes. I think that is the foundation of learning mathematics.

After few years, I am admitted to a primary school. I don't have many friends to go to school with from my neighborhood. One morning on the way to school I see Dalle and Prime playing at the riverside; I hide my bag and join them to make clay models of cars and animals. After some time, my parents know about loss of my bag and I do not go to school for many days. They do not insist on me going to school, rather they send me to graze cows and buffaloes. I am happy to do the work instead of going to school. It continues for two years.

One day a gentle man of my village comes to our house. The man asks my father about my schooling. When he discovers that I am not attending school he advises my father to admit me to the local school. After a few days, my elder brother takes me to school to admit me to grade one. I learn numbers and operations in a year with my friends and teachers. I learn more from my friends than from my teachers. My informal cooperative learning becomes stronger in successive grades.

I complete my high school in the year 1989 from Adarsha High School, Lalmatiya Dang. Then I come to Kathmandu for my higher study. I gain admission to Amrit Science Campus. I study there for two years and then join the two years

Bachelor of Education (B. Ed.) Program at Mahendra Ratna Campus, Tahachal majoring in mathematics and science education. I complete B. Ed., B.Sc. B.Com. B.L. from different campuses of Tribhuwan University during the period of 1992 to 1999. I also complete M.B.A., M.Ed.(Mathematics) and M.A. (Pol. Sc.) by 2003. In almost all degrees except I. Sc. first year, I study privately by myself as a tourist student without attending campus classes.

I move to different places in the course of my job. I work in Bageswari High School at Dhading for a year, Adarsha High School Dang for a year, Hima Ganga Secondary School Rawadolu, Okhaldhunga for a year, New West Point Higher Secondary School, Beni (Myagdi) for a year, and rest of the ten years in the Kathmandu Valley. I teach mathematics and science in these schools. I also work in some private schools in Kathmandu. I work as a mathematics teacher in Mount Glory Boarding High School and management teacher in Rhododendron International Higher Secondary School for four years. I also teach Inferential Statistics in Mahendra Ratna Campus Tahachal, Kathmandu for three years. I teach algebra, analysis and geometry to graduate and under graduate students informally as private tutor. This experience enriched my theoretical understanding of abstract mathematics and teaching of mathematics.

My thirst for further study does not remain idle. I join M. Phil. study in Kathmandu University, School of Education, in the year 2005. This becomes a turning point in my career and educative practices. I get an opportunity to teach PGDE students as a part-time faculty member. Later I get an appointment as a full-time faculty member under the designation of teaching assistant. This teaching practice provides me enough opportunity to learn about recent paradigms of teaching mathematics, constructivism and research practices. Obviously, it helps in my

paradigmatic shift from traditionalism to constructivism and ultimately leads to my pedagogical metamorphosis from a novice educator and researcher to a constructivist /postmodernist educator and researcher in a few years, in the days to come.

I am hopeful to complete my Ph.D. by 2010, either from KU or abroad. My research area can be critical/ethnomathematics education (curriculum and practice) or critical school leadership for quality education. I think my quest for new avenues will lead me towards my ultimate goal of gaining nirvana in the cycle of birth and death, with some contribution to both my country and the world. This research is a search of me and my practices in socio-cultural context situating myself at the centre throughout the research.

CHAPTER 1

MY JOURNEY OF RESEARCH AND METHODOLOGY

My Understanding of Research

During my educative process of M. Phil. Study, I tried to understand the meaning of research. I studied some research method books. Some books I found traditional and some books to some extent modern in terms of defining and viewing the research. I think that every researcher should understand what a research is and what are different schools of thoughts in the perspectives of a research. During review of research books, I found differences in the way the authors defined research. These made me confused in the understanding of what a research was because some definitions were too specific and some were too general.

I found a definition in a book, “Research may be defined as the systematic and objective analysis and recording of controlled observations that may lead to the development of generalizations, principles, theories, resulting in prediction and possibly ultimate control of events” (Best & Kahn, 1999). To me this definition made me clear about some basic attributes of research such as systematic and objective analysis and recording of controlled observations. But this definition has not mentioned about the position of researcher in the research. It is more deviated towards scientific research. In my understanding this definition of research does not cover all the ontological and epistemological assumptions of research. Over the past quarter century and increasingly in the past decade, the human and social sciences have undergone a proliferation and diversification of epistemological paradigms, or models of valid knowledge, research methods and how knowledge is produced (Bentz &

Shapiro, 1998). Modern research incorporates cultural voices and social perspectives claiming to be represented with the public arena and discourses of knowledge.

I cannot say when I first perceived the meaning of research unconsciously. But I can say that it is still difficult for me to get the exact and concrete meaning of research. Which is my first research can be a question? Is it the first research to me when I report my teacher about how the caterpillar turned into a beautiful butterfly? Is it the first research to me when I report my parents that the fish at the nearby river are not edible (when I find dirt in their stomach)? Or is it the first research when I write a small project on “Forced Labor in Nepal” in one of my bachelor’s degree? Any way, I think that I should have more or less concept of research in my mind before I formally conducted a survey of school mathematics teachers about their opinion on the mathematics curriculum during my Masters of Education in Mathematics.

During the journey of research I went through a book "Mindful Inquiry" by Bentz and Shapiro. I found the book interesting as it speaks of the research in the social arena. I agree with Bentz and Shapiro (1998) that research is always carried out by an individual with a life and a lifeworld, a personality, a social context, and various personal and practical challenges and conflicts, all of which affect the research, from the choice of a research question or topic through the methods used, to the reporting of the research outcome. In the social context I believe, as Bentz and Shapiro (1998) state, that the person is always at the center of the process of inquiry and that I will always be at the center of my own research, which in turn will always be part of me. I believe this to be true not only in a psychological sense- for example, in the way that being insecure about my intellectual ability can create ambivalence about my work or that my personality style can shape my choice of a research method -but in a

philosophical sense-for example, in seeing research not as disembodied, programmed actively but rather as a part of the way in which I engage with the world.

My understanding of research is in the philosophical stand of mindful inquiry that includes a number of ideas from four traditions of: phenomenology, hermeneutics, critical social science, and Buddhism. Phenomenology is the analysis of consciousness and experience, hermeneutics is the analysis of texts in their context, critical social science is the analysis of domination and oppression with a view to changing it, and Buddhism is a spiritual practice that allows one to free oneself from suffering and illusion in several ways, one of which is becoming more aware (Bentz & Shapiro, 1998).

I feel that the ideas of mindful inquiry from the four traditions shape the philosophy of the researcher about the research which affects all the elements of inquiry. It depicts the assumptions of mindful inquiry that I feel are part of a researcher's core beliefs, such as: (i) awareness of self and reality and their interactions is a positive value in itself and should be present in the research process; (ii) tolerating and integrating multiple perspectives; (iii) bracketing our assumptions and looking at the often unaware, deep layers of consciousness and unconsciousness that underlie them, human existence;
(iv) as well as research, being an ongoing process of interpreting both one's self and others, including cultures and subcultures, and (v) all research involves both accepting bias – the bias of one's own situation and context – and trying to transcend it (Bentz & Shapiro, 1998).

Bentz and Shapiro (1998) further state that we are always immersed in and shaped by historical, social, economic, political, and cultural structures and constraints, and those structures and constraints usually have domination and

oppression, and therefore suffering, built into them; knowing involves caring for the world and the human life that one studies; the elimination or diminution of suffering is an important goal of or value accompanying inquiry and often involves critical judgment about how much suffering is required by existing arrangements; and inquiry often involves the critique of existing values, social and personal illusions and harmful practices and institutions. I think these are the essential issued to be captured in a research in education.

In my understanding, inquiry should contribute to the development of awareness and self reflection in the inquirer and may contribute to the development of spirituality; inquiry usually requires giving up ego or transcending self, even though it is grounded in self and requires intensified self-awareness. Inquiry may contribute to social action and be a part of social action; the development of awareness is not purely an intellectual or cognitive process but a part of a person's total way of living his/her life (Bentz & Shapiro, 1998).

Selection of Research Topic

I was in the journey of research but I was not able to shape a topic in the researchable form. I was not consistent in the selection of a research area and then the topic of research. Really, I feel that it is a difficult process for a novice researcher like me.

For me, to find a research topic was to find a pearl on the infinite beach. Thousands of shells are found on the beach but rarely does one of them give us pearl. Thousands of research areas were there but it was difficult for me to shape one into researchable form. I faced the problem since the very beginning of this study. In my usual class on research methods, I first tried to go with "Effectiveness of a

Collaborative Classroom on Learning Mathematics". That was a kind of experimental research and I found some difficulty in the formation of the experimental group and control group. Also it was necessary to design the teaching content and program for a collaborative class. I found the project a little too vast for me due to time constraints and other resources.

Then I shifted to "A Study on the Viability of the Mode of Distance Education in a Nepalese Context". One of my professors advised me not to select the area as there are no literatures or research studies in the area in a Nepalese context. I would have to design different modes of distance education and test their effectiveness in a Nepalese context. It was very ambitious and beyond the scope of my capacity in terms of ability, resources and time.

When I started teaching in the School of Education, Kathmandu University as a part-time faculty member, I got a lot of support and advice from Assistant Professor Bal Chandra Luitel and Professor Tanka Nath Sharma. They advised me to do research on mathematics education. I liked the idea because I was from an education background and had experience of teaching mathematics in schools and colleges for about a decade. Moreover, I was appointed as s fulltime faculty member in the School of Education in Kathmandu University when the conception of this research began. Thus research in mathematics education became more relevant for my professional development as a mathematics educator.

I had a strong impression of quantitative research as the exact way of doing research for the process of knowledge building. I think it was due to my positivist approach that involved a definite view of social scientists as analysts or interpreters of their subject matter (Cohen, Manion & Morrison, 2002). When I read the book "Research Methods in Education" by Cohen, Manion and Morrison (2002), I got ideas

of scientific and positivist methodologies, naturalistic and interpretive methodologies, and methodologies from critical theory. According to Hitchcock and Hughes (1995) as cited in Cohen, Manion and Morrison (2002), ontological assumptions give rise to epistemological assumptions; these in turn give rise to methodological considerations; these in turn, give rise to issues of instrumentation and data collection. My interest in research shifted from quantitative to qualitative and from positivist – naturalist to critical theory. This shift became solid when once in December, 2005, Assistant Professor Bal Chandra Luitel gave me his Master's thesis to read and reflect on. I read it thoroughly. I found it very interesting and full of rich mathematical literature. It was like 'water for a frog after long drought'.

I thought to choose my research area in constructivism in mathematics education. How to start and how to shape it was still a dilemma. I read some literature on constructivism but still I was not sure about how to design my research. In my understanding, constructivism has a multitude of forms and appearances as a theory of learning, theory of teaching, theory of education, theory of cognition, theory of personal knowledge, theory of scientific knowledge, theory of educational ethics and politics and constructivism as a world view (Matthews, 1998).

I was in the position to argue that constructivism was a new avenue in research especially in the Nepalese context. I thought it would be good to conduct research in this area. So far as literature was concerned, there was very little research in this area in Nepal, especially in mathematics education. I think that the practice of constructivism in teaching and learning of mathematics at the school level in Nepal is not supported by theory or formal training, but occurs only as a result of teachers' and students' personal efforts and that there might be done unknowingly in practice.

However I felt that this practice occurred rarely as our mathematics classes were guided by conventional approaches of teaching mathematics.

At first I thought to conduct interviews with KU graduate teachers about their perception of constructivism and then to observe their classes and to study their practice of constructivism in the classroom. But after reading Bal Chandra's Master's thesis, I was impressed by his artistic writing in representing his lifeworld. What are the practices of teaching and learning of mathematics from a constructivist's lens in Nepalese High Schools and Colleges and how can the practice be helpful for transforming from traditional approaches of teaching and learning into a constructivist approach? I wanted to dig out from my own experience from early childhood until now and further possibilities as part of a new avenue of my professional journey.

Then I read a few chapters of the Handbook of Qualitative Research (third edition) edited by Denzin and Lincoln (2005). After reading a few chapters I again turned to the pages of Luitel (2003). *Narrative explorations of Nepali mathematics curriculum landscapes: An epic journey.* I could understand the praxis in the thesis more than before and I thought to write a thesis on the basis of my own experiences as a student, a mathematics teacher and an educator.

I wrote ten possible topics on a blank sheet and then chose the best one from five pairs. Then I selected two from the five topics and lastly chose the one which my other half suggested. So the topic of my research became "My Journey of Learning and Teaching Mathematics from Traditionalism to Constructivism: A Portrayal of Pedagogic Metamorphosis".

I was aware that my methodology of finding reality or getting information, in my research is affected by my ontology, epistemology and axiology. So, in this research I wanted to use my experiences for data as they are the ultimate source of

information for me to know the context of learning mathematics from early childhood until now and the teaching of mathematics along my journey as an educative process. From constructivist point of view, I think I have been the closest observer of how I have practiced teaching mathematics at different levels.

Situating Myself in a Culture of Inquiry

In my understanding, a culture of inquiry is a chosen modality of working within a field, an applied epistemology, or working model of knowledge, used in explaining or understanding reality (Bentz & Shapiro, 1998). I think that persons from various disciplinary backgrounds may work within the same culture of inquiry. In all disciplines except anthropology and history probably the majority of researchers work within a culture of inquiry shaped by quantitative and behavioral science (Bentz & Shapiro, 1998). Theories of social organization and of human behavior cluster in various disciplines, but they also overlap. Culture of inquiry or research method to me basically is guided by three primary cultures – phenomenology, hermeneutics and critical social science- may be carried out mechanistically or superficially (Bentz & Shapiro, 1998). One may ritualize them or their procedures and hence not carry out research in these traditions in a mindful way.

In order to properly carry out a culture of inquiry, I prepared to become a participant in at culture of phenomenological and critical social science and critical theory. I interacted with Mr. Bal Chandra Luitel and Dr. PC Taylor in that culture, read various papers and took classes. To become a skilled inquirer within this culture of inquiry, I read research written within that approach, both articles and books; I read works on the theory of qualitative research with various approaches, including its epistemology and methodology; I wrote reviews of such work; I did some exercises

using the method and collaborated with skilled practitioners such as Bal Chandra Luitel (2003) and Peter Charles Taylor (2005) in the culture (Bentz & Shapiro, 1998).

So my culture of inquiry was delineation with the culture of autoethnography closely guided by phenomenology and hermeneutics together with critical theory. My reflective practices of my personal experiences with the cultural context situated me in a culture of autoethnography with critical theory positioning me at the center in the culture.

Situating Myself within Research Traditions

In my understanding, a culture of inquiry is a broad family of approaches within a certain epistemology, that is, a conception of what knowledge is and how it is generated; a research tradition is something more concrete (Bentz and Shapiro, 1998). In my understanding it is a body of research on a particular subject that has evolved over time, carried out within either a particular culture of inquiry or using a particular research methodology, often within a particular theoretical framework (Bentz & Shapiro, 1998).

I think that the notion of a research tradition includes what investigators within the tradition actually experience and think of it as such. That is, they refer to each other's work and to the same paradigmatic studies, and they discuss and define their methods within an evolving body of knowledge. Often researchers within a common research tradition use the same terms and concepts, publish in the same journals and attend the same conferences.

I think a new research tradition has emerged in the arena of Nepali research. The duration has not been long. The conception of such critical inquiry took place in the form of autoethnographic research on "Narrative Explorations of Nepali

Mathematics Curriculum Landscapes: A Epic Journey" by Bal Chandra Luitel in 2003. The researcher has explored a series of experiential relationships between his educative contexts and himself. Reconceptualizing relationships between self and other took him into the world of autoethnographic genres (Luitel, 2003). Similar to what Luitel experienced, I have tried to situate myself in the world of autoethnographic genres inclined with the idea that my personal values cannot be separated from my professional life (Luitel, 2003). I think that constructing a map of research traditions is essentially the exercise one should go through for a survey of a given discipline or sub-discipline. In this context I conducted a survey of what qualitative research is and the traditions that are in it. Then I tried to draw a map of the various theories, identifying major questions, getting acquainted with leading researchers and theorists in the area of qualitative research and autoethnography as experienced by Bentz and Shapiro (1998).

I found me in the autoethnographic genres of inquiry together with Montgomery (2005), and through this narrative process a coherent set of my beliefs emerged. In the writing process I came to realize that I believe teaching and learning are primarily relational (Montgomery, 2005, in Taylor & Wallace, 2006). Because, I have learnt a lot about research and pedagogy during my teaching to the students I have tried to research my own beliefs, practices and pedagogical transformations by linking Van Maanen's (1988) ethnographic genres with a theory of truth as coherence and with a hermeneutic of self adapted from Ricoer (Boje, 2001, as cited in Montgomery, 2005). I found myself confronted with choices – research related choices – that had close ties to my past and present (Settelmaier, 2005, Taylor & Wallace, 2006). Whilst traveling the road of past experiences, nodal moments, epiphanies and past decisions, I realized how closely connected were my research and

my autobiography. These insights contributed to my writing autoethnographically throughout the research (Settelmaier, 2005, in Taylor & Wallace, 2006).

Autobiographical research refers to a family of related forms of self-study, including auto/ethnography (Ellis, 1997. as cited in Pereira, Settelmaier & Taylor, 2005), life history research (Casey, 1993, as cited in Pereira, Settelmaier & Taylor, 2005), testimonio (Tierney as cited in Pereira, Settelmaier & Taylor, 2005) and writing as inquiry (Rechardson as cited in Pereira, Settelmaier & Taylor, 2005). Pereira, Settelmaier and Taylor (2005) further state that educators have a range of methodological tools for addressing Parker Palmer's (1998) challenging "who" question, either as lone contemplatives or as interactive facilitators of change in their professional cultures. Here I find myself aligned with Pereira, Settelmaier and Taylor (2005) who have heightened my reflective awareness of my embodiment of the culture of my profession, bringing to consciousness the moral, ethical and political values that shape my educative relationship with students and colleagues. I think this depicts my situatedness in the paradigmatic shift from positivist to critical theory of research that is towards postmodern research.

I think that I have shifted to a postmodern genre of self-conscious dialogical writing and I value this form of writing because of its educative potential (Pereira, Settelmaier & Taylor, 2005). So I find myself situated with Pereira, Settelmaier and Taylor (2005), Rodriguez (2005), Kincheloe (2005), and Luitel (2005) in my journey of research. I find myself situated also with Geelan (2005) when he says that writing the impressionist tales and weaving them together with other empirical materials to richly represent his experiences within the school are described in text. I feel as Geelan (2005) that narratives about teaching are powerful because they take into

account not only current practices and situations but also the past lives and experiences of teachers, and their future aspirations.

In this way my situatedness lies with the qualitative socio-critical self-reflective inquiry (Bentz & Shapiro, 1998), empowered by auto/ethnography as my genre of writing for research (Van Manen, 1988) and for educating the self. Philosophically I find myself situated within a postmodernist approach of inquiry through reflective practice of autoethnographical genres of writing and research that display multiple layers of consciousness, connecting the personal to the cultural (Ellis & Bochner, 2000, as cited in Alsop, 2005).

I dreamt to situate myself in the lived culture and tradition of research in order to raise my consciousness towards the application of postmodern approach of writing, research and pedagogy from critical social perspectives. It offers me an opportunity to critique my practices of teaching, learning of mathematics and research and ultimately helps of me to understand who I am. But paradoxically I have used the Western texts in order to understand my approach to learn and teach mathematics because I could not find sufficient literatures of the East concerning my pedagogical practices in sociocultural contexts. And other way my educative practices were dominated by the literatures of the west.

Purpose of the Study

The main purpose of this study is to explore my practices of learning and teaching mathematics from early childhood to university level and identify my journey of pedagogical metamorphosis not only to improve my practices but to provide an account of how a novice teacher can transform into a postmodern educator and a researcher through rigorous educative process.

My Research Questions

How to write research question was a problem to me at the beginning. The nature of the research made me aware of forming the research question that could be relevant to the autoethnographic genre of writing as a research situating me in the cultural context. I have formulated the following research question in the process of enquiry.

Principal Research Question: What are the socio-cultural contexts of teaching and learning of mathematics in Nepal and how do they influence pedagogical practices?

The subsidiary research questions, based on the principal question are:

1. To what extent does the mathematics teaching and learning in schools incorporate informal mathematics learnt by the children?
2. How does cooperative learning help in developing an understanding of the nature of mathematics?
3. To what extent has traditionalism been transformed into constructivism in my practices of teaching and learning of mathematics?
4. What are the factors that have contributed to the paradigmatic shift from positivism to postmodernism in my philosophical standpoint?
5. How does cultural context affect the practices of teaching and learning of mathematics?

I have indirectly dealt with the research questions in the subsequent chapters and it is necessary to go through all the chapters in order to understand the answers to the research questions. I have not answered these questions in specific form; moreover the readers get the answers when reading of the dissertation is complete.

Significance of the Study

This study is significant to me, teacher educators and researchers in the following ways:

First the research should help me by means of the self-reflection to understand myself, my teaching and learning processes and my background regarding finding the answers to the question: Who am I? The research will help me to transform myself from a traditional to constructivist educator and researcher.

Second, this is an opportunity for me to shape my own research practice based on narrative inquiry of my lifeworld which is one of the contemporary qualitative research approaches of the postmodernist period. So the research will transform my worldview from an objectivist (structuralism) to subjectivist (poststructuralism or postmodernism).

Third, I hope my writing stimulates and benefits my readers to think critically and participate in reflecting on themselves through reading my narratives. So the readers will understand the paradigmatic shifts and it will encourage them to adapt a transformative educational pedagogy.

Lastly, I expect that this research will help Nepalese researchers to become aware of new approaches of qualitative research in the context of the Nepalese Education System. It will envisage new avenues of research and pedagogical practices in the context of bridging between the localization and globalization of knowledge for equity, access and quality of education through democratic practices in the nation.

My Research Methodology

How to collect data from my experience? How to present it in a coherent structure? What are to be considered as valid information from the self-narratives? How do my experiences represent the experiences of a Nepali Teacher and an educator in the cultural context? To what extent my personal experiences can be a source of knowledge? I was in dilemma about autoethnography as a genre in my research. I got some ideas from Bal Chandra Luitel and then from PC Taylor. Tailor (2006) in personal communication encouraged me to situate myself in the socio-cultural context through multiple genres of texts and textuality.

In this study, I have tried to adopt a qualitative and social by critical approach to inquiry subscribing to the multiple genres of textual representation in order to portray my experience of the context taken under this study. I am not be abiding by the scientific methods of inquiry, which depict the image of the inquirer as detached and his/her, inquiry as a value free enterprise (Cohen, Manion & Morrison, 2002). Furthermore, I believe that the methodology is not independent and universal: rather it depends upon the nature of the research problem and is derived from ontological and epistemological underpinnings (Cohen, Manion & Morrison, 2002). Consequently, I have discussed the ontological and epistemological considerations, the nature of phenomenology, and the methodology for the proposed research.

My Ontological Assumptions

Ontological assumptions concern the very nature or essence of the social phenomena being investigated (Cohen, Manion & Morrison, 2002). In my understanding this assumption deals with the social reality external to individuals – imposing itself on their consciousness from without – or is it the product of individual consciousness (Cohen, Manion and Morison, 2002). Cohen, Manion and Morrison (2002) further raise the questions: Is reality of an objective nature, or the result of individual cognition? Is it a given out there in the world, or is it created by one's own mind? I think these questions spring directly from what is known in philosophy as the nominalist – realist debate (Cohen, Manion & Morrison, 2002). The former view to me holds that objects of thought are mere words and that there is no independently accessible thing consisting of the meaning of a word. The realist position, however, to me contends that objects have an independent existence and are not dependent of the knower (Cohen, Manion & Morrison, 2002). My ontological assumptions are substantially nominalist through which I claim that all that we know are particular objects ("this chair," "that chair") and that there is no such thing as a universal ("chairness"). Nominalism comes from the word meaning "to name" - thus we only ascribe names to individual things based on our ideas, not on the things in themselves. How one explains the fact of the ideas of universals is explained in various ways. The Nominalist view arises out of a strict materialist view of reality, which is that only physical things exist outside the mind. Obviously no two material objects are each other, therefore universals are just labels we use for the particular ideas in our mind.

My Epistemological Considerations

Epistemological considerations are the very basis of knowledge, its nature and forms, how it can be acquired and how it can be communicated to other human beings (Cohen, Manion & Morrison, 2002). Cohen, Manion and Morrison (2002) further ask whether it is possible to identify and communicate the nature of knowledge as being hard, real and capable of being transmitted in tangible form, or whether knowledge is of a softer, more subjective, spiritual or even transcendental kind, based on experience and insight of a unique and essentially personal nature.

In my understanding, the view that knowledge is hard, objective and tangible will demand of researchers an observer role, together with an allegiance to the methods of natural science; to see knowledge as personal, subjective and unique, however, impose on researchers an involvement with their subjects and a rejection of the ways of the natural scientist. Specifically, I hold the view that the notion of an objective world is due to one's observational and theoretical standpoint for explaining the nature of reality. Inductively, to depict reality as out there and unchangeable is to promote a one-sided theoretical and observational standpoint. Consequently, my epistemological beliefs have been formed according to the notion of a postmodern constructivist standpoint, which subscribes to the notion of representing multiple subjectivities to communicate with the readers the subtle, tacit and subjective nature of knowledge. In essence, the proposed research will follow epistemological pluralism, namely multiple forms of constructivism or antipositivist (Burrel & Morgan, 1979 as cited in Cohen, Manion & Morrison, 2002). I think deduction, induction, and intuition are all valid human ways to deal with information. I'll stick with the hypothesis that the physical world is isomorphic to what is perceived, and that I perceive the same blue as you. Human mental architecture is consistent.

Perceptions are precise if not completely accurate. For instance, we see separate bands of color in a rainbow, though in reality the gradation is linear. So we do not see true reality. This does not imply that none exists. I trust in the Consensus, the perceptual patterns that most humans share.

The mind is no blank slate. The heuristics and algorithms contained within it determine how people obtain, process, and structure information. It is no coincidence we relate intimacy with closeness, or happiness with warmth, or desire with hunger. Our perception reflects our embodied existence. We know causal and spatiotemporal relations *a priori*. Image schemas like Source-Path-Goal and Inside-Outside determine how we see reality.

My Phenomenological Considerations

In classic usage, the term phenomenology means the study of appearances (Bentz & Shapiro, 1998). In current usage, introduced by Husserl (1962), it means studying the way in which things appear to consciousness and, therefore, also the way in which consciousness is structured such that things appear to it in the ways that they do. According to Husserl's phenomenology, consciousness is always "intentional" (Husserl, 1962). Hence the notion of phenomenology to me deals with the study of the development of human consciousness and self-awareness within the frames of observed phenomena (Gubrium & Holstein, 2000).

In the context of educational research, phenomenology implies examining the lived experiences of pedagogical contexts (Van Manen, 1990). Furthermore, Van Manen (1990) discloses that the notions of phenomenology are to deal with soft, soulful, subtle and sensitive lived experiences, and to bring them to our reflective awareness. Similarly, Geelan and Taylor (2001) have described that their lived

experiences helped them to form a canvas to portray a portrait of science and mathematics teachers. Clandinin and Connelly's (2000) emphasis is on the reflection of educative experiences for improving the practice of teachers and educators. Illuminated with these standpoints, I will consider the value-laden, context oriented, and subjective portrayal of the educative phenomena, which are the sources of my lived experiences (Luitel, 2003).

My Research Method

I have followed an autoethnographic method of inquiry. In autoethnography, the author of an evocative narrative writes in the first person, making themselves the object of research and thus breaching the conventional separation of researcher and subjects (Jackson, 1989); the story often focuses on a single case and thus breaches the traditional

concerns of research from generalization across cases to generalization within a case (Geertz, 1973, Ellis & Bochner, 2000, as cited in Newton, 2004).

Etymologically, the term autoethnography comprises three different words: auto, ethno and graphy, which signify the textual representation of one's own personal experiences in his/her cultural context (Luitel, 2003).

Autoethnography is "…research, writing, and method that connect the autobiographical and personal to the cultural and social context. This form usually features concrete action, emotion, embodiment, self-consciousness, and introspection…and claims the conventions of literary writing" (Ellis, 2004, p. xix, as stated by Jones, 2005).

Further, Spry (2001) states that autoethnography is a self-narrative that critiques the situatedness of self with others in social context (p.710). Jones (2005)

states that autoethnography involves setting a scene, telling a story, weaving intricate connections among life and art, experience and theory, evocation and explanation … and then letting go, hoping for readers who will bring the same careful attention to our words in the context of their own lives (p.765).

Autoethnographic inquiry subscribes to the nomolithic worldview (Denzin & Lincoln, 2005) what reacts radically against the realist agenda of ethnography. Autoethnographic writing can be depicted as the metaphor of a camera (Ellis & Bochner, 2000 as cited in Luitel, 2003), which focuses on the rarely heard stories (Van Manen, 1988).

I have experience of being a small and innocent boy playing naturally in my own style collecting wooden pieces, pebbles and leaves in a silence and lonely small hut in a remote village. The silence and gentle play of the strange small boy was in one place that I tried to look for ways to critically explore the boy's learning of mathematics and pedagogical metamorphosis and beyond, for me, includes many pretexts including the present guise of being a teacher educator. These homunculi inform the turn to the past while the present informs the “biography as it is lived” (Pinar, 1976, as cited in Autrey, 2003). In other words I take myself and my existential experience as a data source as Autrey (2003) has rightly mentioned in her research on "Trouble on Girls: Autoethnography and the Classroom". In my understanding this is not the only data source; research narratives, but particular genres of story and a resource for data outside of the idiosyncrasy of my own biography.

I have tried to look me from myself not from others' self because that makes me more aware of my pedagogical practices and research methodology from postmodern perspectives. It also makes me more responsible in the process of

narrating my experiences from the past to the present in order to interpret my own consciousness in the sociocultural contexts.

Closing this brief introduction of the research method, I will discuss some specific issues of the inquiry process.

Writing: A Method of Inquiry

Richardson, Adams and Pierre (2005) have stated that unlike quantitative work that can carry its meaning in its tables and summaries, qualitative work carries its meaning in its entire text. I think that just as a piece of literature is not equivalent to its 'plot summary,' qualitative research is not contained in its abstract. Qualitative research to me has to be read, not scanned; its meaning is elicited in the reading (Denzin and Lincoln, 2005). So its power or rigor lies in writing the research. I will take into account Van Manen's (1990) notion of writing as lived experience for creating dialogic relationship between the author and the readers. Further, I will put an emphasis on creating pedagogically thoughtful text by considering the four criteria - orientation, strength, depth, and richness-as discussed by Van Manen (1990) and Geelan and Taylor (2001).

Orientation. The meaning of orientation is to focus on the research question from the perspective of the lived experiences of the researcher. It also indicates the researcher's need to view self and other's lives from pedagogical perspectives (Luitel, 2003). In this study, my orientation is on my research questions based on my own experiences. I have reviewed my past to present and envisioned my future during this journey.

Strength. The strength of my text has to be reflected in the degree of pedagogic interpretation of a certain phenomenon. It also indicates the degree of

pedagogically dialogic relationship between the author and the readers (Luitel, 2003). I have tried to link my lived experiences with the pedagogical advancements and self-transformation during the course of this study.

Richness. Thick description of phenomena is considered appropriate for representing my lived experiences. Specially, the uniqueness and irreplaceable nature of stories and narrative genre of writing can embrace the multiplicity and richness of phenomena (Luitel, 2003). I have to maintain richness of my writing linking my experiences with contemporary theories and experiences of others.

Depth. Depth is related to the explanatory dimension of the phenomena. Depicting a phenomenon in texts may not be depthful unless it uncovers the multilayered nature of lived experiences and its profound meaning within a pedagogical context. Furthermore, the textuality should be capable of connecting the readers' experience with their pedagogical context (Luitel, 2003). Depth of this study lies in the connection of my experiences from early childhood to till the date throughout the process of learning, teaching and self-reflecting.

I have written some of my narratives in present tense in order to give dramatic impression and some accounts are in past tense to give historical sense.

Performative Praxis: Autoethnography as a politics of possibility

I believe that research is a politics and it is politics of gathering data to verify one's biased assumptions and values. Autoethnography is a strong basis to establish personal politics in the form of research and in the form of pedagogy.

Denzin and Lincoln (2005) state that drawing on the lessons that the turn toward personal narrative and performance has taught us, write your stories as they are constructed in and through the stories of others (readers). Denzin and Lincoln (2005) state that look at the intersections in the work of personal storytellers, performance ethnographers, and social protest performers…radically contextualize your texts and your subjectivity; embody personal and community accountability; attend to connection without collapsing or foreclosing debate, dialogue, and difference; move people to understand their world and its oppressions in new ways; and create possibility of resistance, hope, and –yes-freedom.

Alexander (2003) states that we should ask how our texts can write and constitute social action – how our words can make a difference in and outside of individual processes of knowing and coming to know- and then write them and share them, which is the future of autoethnography (Denzin in 2003).

It is the challenge of telling and showing, to borrow from Ellis (2000), stories that are not only necessary but also full of possibilities (p.275). To my understanding, autoethnography is the politics of personal portrayal on the canvas of social and cultural context with the possibility of creating tensions and subtle way of resolving them.

Challenges

In my understanding, challenges make researcher wakeful and careful about the research. No research is challenge free. I think it is not a research if it does not have any challenges. Qualitative research has more challenges in comparison to quantitative research because qualitative research has to maintain its rigor by writing, liveliness, verisimilitude and praxis.

Following are the challenges posed by autoethnography, as stated by Denzin and Lincoln (2005).

Recognize the power of the in-between. I will recognize the power of having it "both ways" (Denzin and Lincoln, 2005) of insisting on the interaction of message and aesthetics, process and product, the individual and the social. I will recall how the crises, turns and movements in and toward narrative, performance, and social protest theater are generated in radical possibilities that exist in these betweens.

Stage impossible encounters. I will create texts that stage what Cohen-Cruz (2001) termed "impossible encounters" in their "capacity to bring people in contact with ideas, situations, or others that appear to be totally different" (p. 105).

Contextualize giving testimony and witnessing. I have to perform the testimony and witnessing of personal stories in, through, and with larger social contexts. I should consider that when we bring our texts to contexts, we can make work that constitutes a first step towards social change. Strive to make work, that "might act as a doorway, an instrument of encounter, a place of public and private negotiations" (Salverson, 2001, p.125 as cited in Denzin and Lincoln, 2005) where the goal is to witness "within the context of the meeting with the person who testifies" (p.121). So my reflections and narratives are the part of my witnessing of the socio-cultural contexts in learning and teaching of mathematics in my perspectives.

Create disturbance. Value texts that "mean to provoke, to raise questions, and to implicate" authors and audiences, texts that create disturbance (Hughes & Roman, 1998 as cited in Denzin and Lincoln, 2005). Capitalize on the complicity wrought in writing and reading autoethnographic texts- in how, when we place our lives and bodies in the texts that we create, engage, and perform, they are "no longer just our own; for better or worse they have become part of a community experience" (Nudd, Shriver, & Gollaway, 2001, as cited in Denzin and Lincoln, 2005). In this study, my concern is in the creation of disturbance in my pedagogical instance and through this process I would like to create disturbance in the thinking of readers so that they reflect on their practices and promise for transformation from positivist to poststructuralists in their pedagogical practice and research.

Make text of an explicit nature. I think that I must respond to the need to be explicit in moving my readers and audiences intellectually, emotionally, and toward concerted social, cultural, and political action. I use my texts to stage arguments, to embody knowledge and politics, to open a community to itself and the world in ways that are dangerous, visceral, compelling, and moving (Dolan, 2001).

Triple Crises

I think qualitative research has been threatened by various issues concerning to its validity, reliability, corroborativeness and commensurability. So I have to address these threats appropriately and timely so that readers will not be in confusion and it will not loose its strength.

It is a triple crisis, a triple threat, a triple crown of thorns: representation, legitimation and praxis (Denzin & Lincoln, 2005). Denzin and Lincoln (2005) further state that the drama of representation, legitimation and praxis is part of ongoing dialogue between self and world about questions of ontology, epistemology, method and praxis: What is the nature of knowing, what is the relationship between knower and known, how do we share what we know and with what effect? What makes this triple crisis feel urgent is the way in which this dialogue has increasingly questioned the stability and coherence of our lives as we live and tell about them. In answering these questions, we have looked into the personal, concrete, and mundane details of experience as a window to understanding the relationship between self and other or between individual and community (Denzin & Lincoln, 2005, p.766).

A crisis is a turning point, a movement when conflict must be dealt with even if we cannot resolve it. It is a tension that opens a space of indeterminacy, threatens to destabilize social structures, and enables a creative uncertainty (Reinelt, 1998, p. 284, as cited in Denzin and Lincoln, 2005).

I have pursued the following strategy to address the crisis of representation:

Multiple genres of textuality. I will use multiple genres of writing to uncover the multilayered meaning of my experiences. I will use poetry, story and fictional writing, drama, dialogue, picture and monologue.

Focusing on the purpose. Representational crisis is also related to the degree of focus on the research objectives/questions. The main purpose of this research is to create pedagogical thoughtfulness among the readers regarding the issues arising in the research questions.

Legitimating the research purpose. The research is aimed at improving my practices. Therefore it is legitimate to my context and me. Furthermore, increasing the verisimilitude and creating egalitarian and dialogic relationship between the writer and the readers can resolve this issue.

The crises of legitimacy and praxis are also connected with the crisis of representation. According to Denzin (1997), the form of legitimacy is extremely political because the discursive system cannot be independent of power and ideology. The notion of very similitude is another criterion for resolving the crisis of legitimacy. According to Denzin (1997), unlike the realist meaning of verisimilitude – "ability to reproduce and map the real", the post modernist verisimilitude is to construct the textual representations as if they resonate with the real. In my research verisimilitude deals with such relation between the text and textuality that renders contextual meaning to the readers. "Meanings are not permanently embedded by an author in the text at the moment of creation. They are woven from symbolic capacity of a piece of writing and the social context of its reception" (van Manen, 1998, p.25 as cited in Luitel, 2003).

Praxis is the nexus between the representation and legitimacy of the research (Luitel, 2003). To some extent praxis may deal with the notion of the theory-practice dualism critical traditions (Quantz, 1992). Van Manen (1990) points out the notion of praxis as "thoughtful action: action full of thought and thought full of action (p. 128 as cited in Luitel, 2003).

I want to summarize the issue of praxis in relation to my research as following:

I have reflected upon my own actions with pedagogical contexts and thoughtfulness. I have maintained reflexivity about how I have represented the experiences. I have maintained reflectivity about what experience I have reflected.

Ethical Issues

I have dealt with the following ethical issues in my research:

(1) I do not claim that my experiences are common to all Nepali students, teachers and teacher educators.

(2) I am conscious about misrepresenting the socio-cultural contexts that may be harmful to the beliefs/faiths of certain persons and / or groups.

(3) I do not claim objective realities in my experiences. It will be subjective and fully subjective as interpretations have been made in my perspectives, but I do not leave the contextuality.

(4) I have cited the literatures that I referred during my study and references have been maintained.

My Chapter Outline

This study report has been divided into six chapters. Each chapter portrays the nodal events in my educative process and they are linked with my pedagogical metamorphosis. I would like to discuss the outline of the chapters in brief. My reflections through narration, poetry, dialogue; pictures, stories and drama are the data in this research. Analysis and interpretation, review and citations have been brought together in each chapter.

Prologue demonstrates my brief journey of education and my aspirations of conducting the research.

Chapter one controls my research process and situates me in the culture of autoethnographic genre of qualitative research. It describes the rigor of my research and its nature.

Chapter two depicts my experiences of learning mathematics informally outside school and formally inside school. This chapter seeks to find out whether there was any link in the two and envisions the possibilities for the bridging the two sides of mathematics.

Chapter three reveals how I learnt mathematics through cooperative learning in informal learning group. This chapter deals with some theoretical perspectives of cooperative learning. The story of cooperative learning of mathematics in five episodes is supported by theories of cooperative learning.

Chapter four discloses the metaphor of pedagogical metamorphosis and the five episodes portray my reflections of how my pedagogy of teaching and learning mathematics passed through ups and downs to reach to the pilgrimage of constructivism.

Chapter five gives a picture of how my pedagogical metamorphosis takes its motion in School of Education, Kathmandu University.

Chapter six describes my realization from the research. It concludes my research in terms of my perceptual change and changes through actions as a result of pedagogical metamorphosis from traditionalism to constructivism.

Hence the six chapters represent moulding of my perception, understanding, realization, self-efficacy and self-critiques on my learning and teaching mathematics.

CHAPTER 2

INFORMAL MATHEMATICS: GROUND FOR FORMAL MATHEMATICS

Introduction

It is a night in April 2006. Crick, crick….. Crick, crick….. I hear insects out-of-windows. There is a faint light in the street far from my room. There is silence and only silence in the street. I think over my early childhood. I remember Karange Kot, a remote village and a lonely house and a boy of three or four years playing with pebbles, wooden pieces and dust. I was about to write my narratives from early childhood. I was in dilemma from where to start and how to start. I wrote a page, torn and thrown into rubbish. I opened my computer and sat in front of the monitor moving my fingers around the keyboard. I tried to put my thought into it but was in vain for a while. I remembered Dr. Taylor and Bal Chandra. I saw them in front of me whispering me to go on. I played the music on the windows media player. I heard sweet voice "My heart will go on" of Selin Dion.

After a while I came across my past: a boy playing with pebbles in a remote village deeply emerged in to his own world without caring others around. Then I start typing few stanzas. I delete and type again. A poet inside me encouraged me and said "Shashi, you go on. Don't care your grammar and structure at first, flow with your feelings and emotions and edit it later".

Grooming over the monitor and moving my fingers for three hours, it came and finally it came. The poet inside me said," Good-luck Shashi!"

My Early Mathematics: Natural Mathematics

Pebbles of diverse faces and color
Metaphors of living cattle
Pairing a big with a small
Representing the caring mother

One-to-one correspondence
Perfect natural game
Odd was out from the set
What a beautiful consequence

Pure … and pure and tranquil
No symbols, scripts or artificiality
Super math with supreme reality
Full of joy and cosmos within a mini feel

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For me, the charisma of mathematics of pebbles and cows of clay models started since spring of 1975 with sprouting blossoms of apricot in front of my house at Karange Kot, Dang, Nepal. I wondered at the changing seasons that brought different colors around my small world. I used to sit at the east door of my small hut when mother went to collect firewood and fodders for cows. I used to collect pebbles to represent animals, family members and some as motorcars. Clay models were my favorite play items. My journey of learning mathematics started unknowingly from childhood before schooling with the pebbles, models, changing seasons and surrounding events.

In this chapter I have tried to identify some linkages between informal mathematics and formal mathematics. I have tried to investigate my learning of mathematics with parents, elders and peers through games, play, day to day work and different activities. I focus on how informal mathematics helped in my learning formal or academic mathematics. I have reflected on my preschool learning and strived to establish a correlation between informal mathematics and formal mathematics. Ethnomathematics has been discussed in the light of popularization of mathematics and making mathematics education more powerful through incorporation of culturally relevant, socially advanced and globally modernized transformative pedagogical reforms.

The Parallels

Dollies, toy-cars, plastic animals, a mini-piano, some rubber balls and blocks are around her. Anjila seems very busy assembling different models from the blocks. She makes a tall building; dismantles it and makes a boat out of it and puts two babies, Pintoo and Mintoo, on it and sails on a virtual river (she imagines a river on the floor carpet). She hums gentle songs. Frequently my eyes go to her genuine play, innocent play and perfectly natural play as I am reading a book.

"The particle interactions give rise to the stable structures which build up the material world, which again do not remain static, but oscillate in rhythmic movements. The whole universe is thus engaged in endless motion and activity; in a continual cosmic dance of energy."

Anjila throws a block as it does not fit properly with others and she softly sobs. I leave my reading and pick her up in my arms and tell her to play with toy cars

and dollies. She starts moving a car on the floor with a dolly in one hand. I turn to the next page.

"….. This dance involves an enormous variety of patterns but, surprisingly, they fall into a few distinct categories. The study of the subatomic particles and their interactions thus reveals a great deal of order. ……The dance of Shiva symbolizes not only the cosmic cycles of creation and destruction, but also the daily rhythm of birth and death which is seen in Hindu mysticism as the basis of all existence. At the same time Shiva reminds us that the manifold forms in the world are Maya- not fundamental, but illusory and ever changing- as he keeps creating and dissolving them in the ceaseless flow of his dance"(Capra, 1989).

Anjila is a little distance from me and I hear her childish hum as she produces sounds of her car. She is pushing a red car up on the corridor (Hui…….n,hui…….n,……..).

I remember a day some twenty-nine years back.

I was moving a truck made of clay, humming to myself loudly when it was climbing up and jolting. (Dhueeeen…….Dhueeeeeeeeeen) The truck overcame the jolting. It turned left and right along the spiral road. I was pulling it with a cotton thread. The truck reached the rocky mountain and I loaded it with some pebbles. (My book falls to the right, but it is still in my grip) Then after a while it was returning to its destination. Suddenly, a shadow appeared from behind me. My truck was brutally squashed under a giant foot and crushed to pieces. Then it flew away as if it was a football. I lay down on the ground, sobbing in mourn at the demise of my truck, my creation, my science and my mathematics.

I was with tears in my eyes when Anjila came to me with a wheel off the crankshaft. I wiped her tears with a handkerchief and mended the car. She smiled at

me and went to play. My book was just at the right side folded down with page 270 at the top “The Parallels”.

Is there any coincidence of her play with toy-car, my play with clay-made-truck and God Shiva's *tandav*? I try to link the mathematical notion with toy-car, clay-made-truck and cosmic cycle of creation and destruction. I think there is a parallel relation of mathematical ideas with Anjila's play with my early experiences. I enjoyed a lot with clay models and she enjoys the same with plastic models. Place is different, time is different but I think feeling out of these is same. So, every child should be given opportunity to explore ideas from objects they play with and games they play.

The dance of bliss or the Ananda Tandavam of Shiva is said to symbolize the five divine acts (Pancha Krityas) of creation, sustenance, dissolution, concealment and bestowment of grace. These five divine acts (Pancha Krityas) form all sorts of mathematics in the universe where my mathematics learning is only an assumption to feel as small as an atom in comparison to the size of the earth and even smaller. So, I

feel that the knowledge claim in mathematics is substantially nominal in my nominalist perspective.

What a coincidence? Anjila's model building, car, dolly and many more … with my clay truck all came to us in the process of childish play. I think that it was how learning mathematics was rooted in my childhood with play and games. Shiva is there to create these parallels and destroy after a while (again a parallel), in a cosmic sense, a very short duration of the periodic motion of his "*taandab*". Perhaps it might be an infinitesimal element in the journey of my learning of mathematics. I feel that the childish play was at one end and super consciousness of mathematics at the door of nirvana is and will be at another end, and that both are at infinite distance of time, length, understanding, history of human civilization, socio-cultural practices and quantum of my pedagogical metamorphosis.

During the past thirty years there has been a growing interest among teachers and educators in the meaning children make of a variety of contexts through their explorations in the world (Worthington & Carruthers, 2003). I tried to reflect upon my childhood activities that were directly or indirectly linked with mathematical concepts and meaning making in terms of number, shape, patterns, structure, relation, similarity and differences. It's really difficult to go back to the past and find important nodal events to link to the present and point at the future. It might be easier to look at what others are doing, to ask what motivated them to learn mathematics. It might be tolerable to gather data from others and interpret to draw valid conclusions but it is really difficult to go deep in to the past of self, to find some important events. So, I have tried to excavate some such contextual events of my childhood, some may be overlapping with others and some may be distinct but I think it is a product of our

society and culture and it can depict contemporary basis to pave the way to present and to go ahead in future.

Studies have focused on emergent writing (Bissex, 1980; Clay, 1975; Hall, 1989), children's schemas (Athey, 1990), drawings, model making and play with objects (Kresb, 1997; Pahl, 1999), early mark making, drama and painting (Mathews, 1999). People have started focusing their writings and investigations on children's schema, drawing, model making and play so that we can better understand the way children learn effectively and make their meanings about the world and so that a better pedagogical metamorphosis can take place for transformative education. How does a child pair objects, form patterns, draw figures and make schema plays a significant role, I think, in the real understanding of the nature of mathematics of childhood and correspond with school mathematics.

None came to say "children make mathematical meaning in multi-modal ways through their play and with a variety of resources and media". I feel that my elders and parents were not supportive to what I was doing in my own way of learning things around. In my understanding why I was doing the things that seemed un-necessary to them and useless in their feeling. It might be that they had their own ideas and opinions about how children learn things and play with objects around. But I was a bit crazy of play and games of my interest which were not of their interest. It could be the possible cause of conflict between parents and me.

Although I did not get support from my elders and parents in my own way of learning mathematics through play and games, I am supporting my daughter even though she plays with artificial objects around her. I want to give her a natural environment but I can't send her to remote rural area to learn from nature. My

pedagogical process is still under transformation and still lacks the elements of radical transformation.

I believe that children's way of making meaning and understanding the mathematical phenomena can contribute a lot to parents' and teachers' understanding of the complex way that children learn. Yes, it seems s fantastic idea. I could draw a parallel line of thought when I observed Anjila's playing with a toy car and my playing a clay-model-truck. Then I remembered Capra (1991) explaining the infinite cosmic dance of God Shiva. Morning shows the day, the productive plant has a smooth leaf in its babyhood, can be a good adage for children's ways of making meaning and understanding mathematics with infinite possibilities in the future. Certainly it becomes a good lesson to parents and teachers if observed carefully, meaningfully and logically. So, I think that children are teachers and teachers are children, and vice versa, in the process of teaching and learning. It seems to me that who teaches and who learns is blurred in the educative process and in the process of pedagogical metamorphosis.

In my understanding, children invent ideas and they create their own philosophical sphere but not necessarily do they know it as philosophy. To me, a violin does not know what music it creates and children don't know what philosophy they might have developed but yes, I think they develop their own philosophy of play, philosophy of world and philosophy of life, though in miniature. When my elders were going to cut the throat of a he-goat and kill it for meat, I used to hide my face. I could not watch the cutting of a chicken from its neck. I realize that it could be a philosophy of "ahimsa" and mathematically a philosophy of "correspondence of life to life".

I think my play with pebbles, clay models, sticks and other play items did not make sense to the world of elders and parents. It was useless and time destroying for them though it gave me heavenly satisfaction, super consciousness to link nature and self. Gura (1992) states that when children engage in play that makes sense to them, and partnership with adults, they can make relationships between practical mathematics and the disembedded symbolism of formal mathematics. Partnership with adults, yes, it could be helpful to learn formal symbolic mathematics by building its relation with the day-to-day life of mathematics. But it was not applicable in my case before my school days though I am now helping my daughter in this regard. Certainly my experience of lust to play and playing materials still reminds me of the past when I see a baby's play things at the side of the road at Sundhara, New Road and Ratna Park. I choose one or two for my daughter although my other half says it as a waste of money.

These are a few examples that researches have been carried out on children's ways of learning mathematics in different corners of the world. In our context, these researches in other countries could have little meaning as the quanta of social and cultural life is different in Nepal. I have not yet had an opportunity to read any research findings about children's informal learning of mathematics in the context of our society and culture. But consciously or unconsciously children are engaged in learning mathematics informally at home, farmland, grassland, riverside or anywhere they play and work. This is likely to have a tremendous effect on the learning of formal or academic mathematics in schools, although teachers might address it or not, though curriculum focuses on it or not. To me, children's learning of mathematics from their surroundings does not stop although it may fluctuate. But it seems more

systematic and relevant to the child if informal mathematics becomes a basis to learn formal or academic mathematics at school and college.

The rhythmic movement of the particles, subatomic particles and the heavenly bodies roaming the vast universe, Shiva's "taandab" and my toy truck and my preschool mathematics; the research findings and construction of new theories all are 'Shangri-La' in my journey of learning mathematics. I am trying to search the social and cultural context within me and from my way of learning mathematics before school, in school and after school. Shiva is there with me in the process of pedagogic metamorphosis, again a rhythm in his cosmic dance, a symbol of creation and destruction, a way of research.

The giant foot that crushed my clay truck might be right as I was indulged in play forgetting everything else. Sometimes elders used to give orders to do a little work at home in my capacity but my play disturbed in the household work. So, they might have taken such steps to divert my concentration towards work. I don't think that they did not have any idea about learning mathematics through games and play. In my understanding simply either they were unaware of the importance of play in the learning of mathematics and in encouraging the creativity of a child or their approach and understanding was different from that I expected. How can I now blame them for not doing justice to me? How can I claim that I was not treated fairly in my play? To what extent were my elders responsible for discouraging or encouraging my learning of mathematics through games, play, models, and other activities at home? These are questions in my thinking but without concrete answers.

Tazard and Hughe's (1984) study of four-year-olds emphasized the child as a powerful learner, struggling to make sense of all around him/her. I think I was a powerful learner. I remember the events of my childhood although it was difficult

after my twenties. I remember how I learnt playing cards though nobody taught me. I remember how I knew how to swim in a river, though I did not get any training, and I still remember how I learnt to ride a bicycle though my elder brother did not let me touch his new bicycle. Carruthers suggests that now we have to move away from the idea of 'human sense' towards observing children's learning in terms of 'children's sense'. Allowing the child to lead can give a deeper indication of their natural development, indicating ways to support their growing knowledge (Carruthers, 1997a, p.13).

So my point of view in this chapter is that there should be a parallel linkage between informal mathematics and formal mathematics according to the cognitive levels of children. I think children have a strong power to learn mathematics during their play, interactions with adults and peers and day-to-day observations. Such informal mathematics learnt by children should be properly identified in a socio-cultural perspective and it should be incorporated in school mathematics. I think development of a child physically, mentally and intellectually is possible if there is a proper connection of informal mathematics and formal mathematics. It seems to me that the way Anjila is learning mathematics is parallel to mine, meeting at infinity at the common point of formal mathematics, though we are close to our educative process. By meeting at infinity I mean the perfect match of informal and formal mathematics is yet an ideal though they are closely related and complementary to each other in the world of mathematics.

Mathematics In and Out of School

My mathematics in school

It should be a day in 1985. Mr. Pravat enters the class with a few chalk-sticks and a duster in his left hand and a bamboo rod in his other hand. His graceful walk toward the classroom makes all of us stop our chatting on the lawn. He enters the class before we can reach in. I am in fear of getting a whip.

Everybody who enters after him gets a whip, a sweet whip, a sharp whip, a hot whip and for some a cold whip depending on his subjective judgment of us. Ritual finishes. He sits on a chair. He moves his hand around his beard and moustache, asks for a book from first benchers, turns pages, and presses one with a palm to keep it open. He stands up and goes to the board with a chalk-stick. He calls me to the front. I approach him with a deep breath. He holds at my left ear-pinnate and gives me a hot slap on my right cheek. Then he speaks, “Didn’t you clean the board?”

I hurriedly (with extreme nervousness) catch the duster and move my (shaking) hands around the surface of the board, a wooden board almost gone off (decayed), to clean it. To my goodness, I do not get another slap on my left cheek as we had not colored the board last Friday (Sometimes being class monitor results into getting slapped when things are not ready on time).

He writes some algebraic formula on the board. He finishes it in two minutes without speaking. The class is in a pin-drop silence, a silence of corpse.

$$(a + b)^2 = a^2 + 2ab + b^2$$
$$(a - b)^2 = a^2 - 2ab + b^2$$
$$a^2 - b^2 = (a + b)(a - b)$$

He turns to us, gives us a crook look. I say crook as his look is dreadful and we cannot smile at his look. He then tells us to read the formula and rote learn it within fifteen minutes. He goes out of the class, spits the tobacco out on the lawn and goes to the office where two guardians are waiting to see him.

A gentle buzz bursts up. All are busy, some shaking their body with perfect rhythm and rhyme in a chorus, some closing their eyes and chanting as mantra.

Some girls (Keshari, Shusila, Kamala and others) are practicing the algebra mantra closing their eyes. Resham and others start chatting about how many birds they killed the night before with their catapult.

After twenty minutes he comes in to the class. The buzzing stops. He takes his chairmanship.

He asks everybody the three formulas one by one. All of us can say without any doubt as if it is obvious to us. He beams alight with gentle smile. Calls me to the board and orders me to clean it.

Nothing except the blackness is left on it. The board is to our memory and vice versa. What a surprising analogy it is to our learning.

He stands up and holds the bamboo rod with his right hand; moves to us.

A fear, terrible fear from heartbeat can be felt. He observes us from head to toe. Then he starts his routine.

He asks Hari Nath to recite the formula.

He can hardly do it.

He points to Govinda. He tries his best but fails in his last step.

He gets a whip at his vertebral column to bend it concave-in.

The ritual continues till the bell rings. Mr. Pravat goes out leaving us in the dark (though it was day).

Ritual of learning mathematics continues at the same manner till I complete my lower secondary level from the school. At that time I think I know almost all from mathematics book but I now realize that how much I could understand and how much I could rote learn at the moment, as it was a terrible learning moment to me. Here, I don't want to blame my teachers but it was the system that made our teachers to be rude to us (students). The good thing at the time I learnt was discipline. There was a very strict discipline in the school. I was very obedient student and I liked my mathematics teacher though he was very strict. His strict nature made me aware towards completing my assignments and hard practice of mathematics with my friends during informal cooperative learning. Still today, he is my respected mathematics 'guru' no matter how his teaching style was and how I learnt mathematics during my primary and lower secondary school.

My Mathematics Outside School

It was a day in 1987. I was in grade eight. I returned from school on time. Though Bharat was insisting me to play *ghuchchi (thow and hit the coin)* for a while on the way, I did not agree. I was anxious to see carpenters making furniture at our home. I arrived home at 4.30 pm within half an hour.

After keeping my bag inside my reading room and then having my Tiffin, I sat at one side and looked at the carpenters work. Five carpenters were busy. One was old-man of around his sixties and others were in their thirties. Within seven days they cut a big wooden log into pieces and then into a few chairs, tables, cupboards and beds. I was amazed on their work. How could they cut wooden log into right size and shape, how could they smoothen the surface and fit into different designs all were miracle to me.

They measured the log, put signs with pencils and cut into smaller rectangular prisms. They again discuss about design of cupboards and finally reached to conclusion. Their instruments (saw, hammer, wedge and others) were also interesting to me. I tried to cut a piece of wood into the shape of a motor-car but I could not do it. One of the youngest from the team came to me and asked what I was doing. I asked him how to cut the wooden piece into right size and shape. He told me that I need practice on it.

I was in grade eight but it was difficult for me to understand how they could measure exactly the volume of wood and size of the furniture. My elder brother was insisting with them on a rack and the oldest of the carpenters was consoling him by telling the biggest possible size. The deal was a difficult problem to me. But my school mathematics did not help me to understand how carpenters measure exactly and design the furniture.

"A variety of researchers in the last fifteen years have described how people use mathematics in out-of-school situations to solve problems and achieve goals" (Masingila, Davidenko, Wisniowska & Agwu, 1994). The authors further state that mathematics learning is not limited to acquisition of the formal algorithmic procedures passed down by mathematicians to individuals via school. According to them mathematics learning occurs as well during participation in cultural practices as children and adults attempt to accomplish pragmatic goals (Saxe, 1988, as cited in Masingila, Davidenko, Wisniowska & Agwu, 1994).

In my understanding there are differences between mathematics practice in and out of school, as well as mathematics learning in and out of school (Masingila, Davidenko, Wisniowska & Agwu, 1994). Mathematics practice in everyday settings differs from school mathematics practice in a number of ways (Lave, 1988 as cited in

Masingila, Davidenko, Wisniowska & Agwu, 1994). According to Lave (1988) in everyday settings: (a) people look efficacious as they deal with complex tasks, (b) mathematics practice is structured in relation to ongoing activity and setting, (c) people have more than sufficient mathematical knowledge to deal with problems, (d) mathematics practice is nearly always correct, (e) problems can be changed, transformed , abandoned and/or solved since the problem has been generated by the problem solver, and (f) procedures are invented on the spot as needed.

Lave (1985) further states that researchers who have investigated how persons solve problems in school-like situations and solve mathematically-similar problems in everyday contexts found that in the former situation people tended produce, without question, algorithmic place holding, school learned techniques for solving problems, even when they could not remember them well enough to solve problems successfully. He further says that when people solved problems in situations that appeared different from school, they used variety of techniques and invented units with which to compute (Lave, 1985).

In this context I remember few events in my early days. Once I went to buy a chicken from neighborhood. I asked the price of the chicken and the owner said that it was three twenties. I paid three twenties and brought a chicken home for meat.

One day I went to neighborhood with my father. Three brothers were going to divide their parental properties among them. They divided other properties themselves but there was problem to divide a piece of land in to three parts. The plot of land was not of regular shape. My father asked a rope with one of the brothers and measured the area of land and divided into three parts by approximation of area. He measured the area of land in square hands.

Once a goldsmith came to our neighborhood to make some ornaments of gold. The gold smith weighed the small amount of gold with red seeds (Raati Gedi) of certain plant as standard mass. He made an earring of twelve laal (twelve red seeds) of gold.

Once my father was sowing gram seeds in a plot of land. He did not measure the plot of land to estimate the amount of seed. He sowed two pathis of grams seeds with his personal estimation.

A butcher came to our neighborhood to buy a hegoat. The butcher held the hegoat at its vertebral column. With the length and width of the vertebral column he estimated its weight and price. The owner was convinced and sold the goat at eight twenties.

Once my mother sent me to a neighbor's house to buy a sher of ghee. The house owner weighed a sher of ghee with a single pan balance with a standard mass fixed at one end of the beam. The weighing was based on the principle of equilibrium of momentum.

Once upon a time, two guests came to stay in our house. They were pilgrimages going to Swargadwari. They told my father to wake them up at the time cocks crow. Next morning my father woke them up at the time the cocks crowed.

Once I was seriously sick at our home. My parents were going to take me to the healthpost but one of our neighbor suggested to call a *Dhami* (Witch doctor). He came with a typical drum set called *dhengro.* He went on playing on the *dhengro* and chanting mantras. His rhythmic mantras and ding-dang-ding of *dhengro* slowly healed my sickness. The *Dhami* used to repeat every rhythmic mantra seven times. He made offerings to seven gods, addressed seven witches in his mantras, and promised to release them if I (Shashi) got relieved. He asked seven pieces of clothes, seven pieces

of fruit, seven lamps made of leaves, and did everything seven times. He had a seven kind of beat in a round of hit in his music in his dhengro. He even danced seven times around me. Everything that he did was linked with seven.

People have been using mathematics and mathematical concepts in building houses, furniture, temple, roads, canals, weaving, arts and crafts, painting and other day-to-day life in their context of social and cultural life.

Knowledge constructed in out-of-school situations often develops out of activities which (a) occur in familiar setting, (b) are dilemma driven, (c) are goal directed, (d) use the learner's own natural language, and (e) often occur in an apprenticeship situation allowing for observation of the skill and thinking involved in expert performance (Lester, 1989, as cited in Masingila, Davidenko, Wisniowska & Agwu, 1994).

Bridging Formal and Informal Mathematics

I think the early notion of mathematics starts from concrete real-world objects. My early observation of objects around me was my play items, fruit, plants and animals, my family members and neighbors, the changing weather, heavenly bodies such as stars and their patterns, the moon and the sun. The visual objects with different characteristics helped me to create a mental picture of them and their attributes. That was a way of learning mathematics informally before going to school. Identification and classification of plants and animals was mathematical thinking in my early childhood. I could identify some animals as a group. I think grouping was somewhat related to the concept of set although the name ‘set’ was not known to me at the time. I could identify some plants, which also is a process of categorization

based on attributes. My understanding of mathematics came through natural play, day to day life and observations around.

Kennedy and Tipps (2000) state that identifying similarity and differences among various environmental stimuli provides early evidences of human learning. Newborns apparently recognize familiar and unfamiliar sounds, voices, faces, and smells and react differently to them. As children grow and have more experiences, they encounter more and different types of objects, events and people. Matching requires recognition of similarities among experiences. Discrimination or differentiation, as a thinking/learning skill, involves recognizing differences. Matching and discrimination almost always occur together; seeing similarities also involves recognizing differences (p.27).

It seems to me that my journey of mathematics learning started around spring of 1975 with simple play that came to my mind with the things around me. "Mathematics is the language in which God has written the universe" (Galileo as quoted in Kulshreshtha, 2006). According to Locke mathematics is a way to settle in the mind of children a habit of reasoning (Kulshreshtha, 2006). My understanding of mathematical concepts started with the simple analysis of objects around me in terms of some basic attributes. I used to select pebbles for my play and selection was based on size (bigger or smaller), surface (smooth or rough), color (white, gray, yellow, black etc.) and shape (elongated, round, oval etc). Grouping of pebbles in terms of these attributes and putting them in pairs certainly represented my mathematical constructions and understanding in an informal form.

Before the game what was my mathematical perception (in the *sensory motor* stage) , I can't share my experience and so it can not be part of my research but I have

started building up my recollections of mathematical understanding since my *pre-operational* stage.

According to Kennedy & Tipps (2000) people believe that mathematics begins when children count and add numbers. In fact, early number knowledge results from thinking and organizing many experiences throughout early childhood. Basic thinking/learning skills develop continually, but in ways so subtle that neither adult observer nor children are fully aware of content and their importance. Basic thinking/learning skills are precursors for content and processes of mathematics as well as for concepts in all subject areas. Five thinking/learning skills are suggested as underlying conceptual learning: Matching and discriminating, Sorting and classifying, Ordering and seriating, Sequencing, and Patterning (p.27).

Learning of mathematics, to me, started when I started counting and adding numbers with the help of real objects during games and play. It seems to me that this activity involved me in matching and discriminating pebbles, sorting and classifying them in terms of color, smoothness of surface, shape and size. The ordering and sequencing of objects and putting them in patterns made me understand the basic nature of mathematics though I came to know the word ‘mathematics’ later during my school study.

Dhunde was in my peer group during preschool games and play. I remember that he first taught me how to make a wind fan that rotated with the breeze. To my surprise, the wind fan made of a mango leaf was my first most favorite play material that helped me to understand the relationship between the speed of fan and that of the wind. He prepared a wind fan on a stick and gave at to me. I ran with the stick and the fan rotated. I stopped and the fan also stopped. I kept on running that day around the mango garden in my village. He taught me how to make such fan from bamboo

scales. I knew how to cut it into a 'z' shape and put a thorn at the middle of two blades. It was like a great scientific invention for child. Dhunde was my first peer who taught me something very interesting and I could never forget it in my life. But now I don't know where he is and how he is. He disappeared from the village when we were at the age of nine or ten. His mathematics is still with me. It was the first applied geometry to me before going to school.

I think that ordering and sequencing occurred in the selection of the most ideal stick from a bundle of sticks to play mini javelin throwing with other boys and girls. I think I was not sure about patterning of objects in my early days, though I sometimes played with kites, boats and paper planes.

It seems to me when the child plays with objects around then he/she develops a sense of one or many, one or other, and this leads to development of number sense. Elders can help children to form such sense more effectively and meaningfully by helping them in patterning and sequencing. The role of elders is to provide the children with a learning environment. The child makes his/her own sense of number (Piaget, nd) although symbolizing is yet far away.

When children are admitted to school they come with their experience and understanding about the world. Does our school system recognize the existing mathematical knowledge and understanding of children before school? In our villages, generally children are admitted to school when they are at the age of five years. I think that at that age they have developed some insights of number sense, counting, patterning and grouping. So, in my opinion, schools need to acknowledge their mathematical understanding and practice the teaching and learning of mathematics in the way they can accommodate best in the school environment.

In my experience, children are rarely involved in games while learning mathematics in school. Our school system has not yet fully recognized the children's mathematical knowledge and understanding prior to their joining school. It seems to me that mathematical understanding that children develop out of school have a great effect in the learning of mathematics at school. In my experience, Babu Ram Gupta was more intelligent in mathematics in comparison to other average students as he used to be involved in his father's small business at home. His counting, addition and subtraction was faster and more accurate than ours. So, I think he was a good mathematics learner in the class. His experience with his father's business helped him to develop a basic mathematical understanding (informal math) that led to his successful mathematics learning at school (formal math). This illustrates why the school system should recognize and incorporate the pre-mathematical understanding of early childhood.

"Most experts believe that young children possess a substantial amount of informal knowledge about mathematics. The teacher's role is to create a link between their ability to use informal math and the ability to understand more formal math found in grade school" (Ginsberg, 1996 as cited in Smith, S.S. 1998). "Teachers must help children construct and elaborate upon what they already know, so they can 're-invent' mathematics for themselves. A reflective teacher helps the children discover and communicate ideas that would not have occurred spontaneously without adult's help" (Vygotsky, 1978 as cited in Smith, S.S. 1998).

I think that our school system and our teaching and learning of mathematics should be child centered. It seems to me that we as students should get lots of opportunities to explore things ourselves and construct meaning out of them; and as teachers we should let our students focus on re-inventing their mathematics. My

experience of teaching mathematics at the school level shows that I did not let my students talk to me or talk to themselves. I feel that the locus of control was with me. I did not give them opportunities to explore mathematics, instead I did it on the blackboard and my students were passive copiers.

Bart (2005) has stated that most mathematicians appear to uphold a hybrid conception of mathematical truth. According to Bart (2005), on the one hand, they entertain a consensual notion, whereby what is true is what is accepted by the community; on the other hand, as this seems to open the door to relativism, they also defend its objectivity, in terms of correspondence (realism) or coherence (formalism). I think that in any case, the community-model of mathematical practice is of high practical value, especially since mathematicians are at least as interested in whether provisional results can be relied on as they are in their ultimate verity of math. Consequently, to me, trustworthiness is a very important issue to mathematicians. However, recently, there seems to be a dramatic increase in the essential 'informality' of mathematical results, provisional or definitive, with a rising number of extremely long, complicated, digital, specialized, experimental or otherwise elusive proofs putting to the test the limits of human mechanical or intuitive mathematical powers. It seems to me might we be at the Pravat of a new crisis and/or revolution in the philosophy of mathematics? A broad specter of empirical material that is possibly relevant to effectively coping with this question is presented and preliminarily commented upon, which will indeed set the stage for more thorough philosophical discussion elsewhere.

In the process of reviewing the book *Rethinking Mathematics: Teaching Social Justice by the Numbers* by Gutstein and Peterson (2005), I found a quotation by a student “I thought math was just a subject they implanted on us just because they

felt like it, but now I realize that you could use math to defend your rights and realize the injustice around you…Now I think math is truly necessary and I have to admit it. It's sort of like a pass you could use to try to make the world a better place" (Frieda, ninth grade, Chicago Public Schools).

Frieda was not positive towards mathematics at first but after knowing that mathematics is not simply a play with numbers but a powerful tool to defend one's rights and realize the injustice around, she realized that mathematics was like a pass that one could use to try to make the world a better place, peaceful, and more creative place for all humankind.

Sam (1999) states, "It is widely claimed in the literature that negative images and myths of mathematics are widespread among the public, especially in the developed countries." Handerson (1981) claims that the "majority of people today are scared of mathematics and mathematicians and feel powerless in the presence of mathematical ideas" (p.12). Many people's images of mathematics represent mathematics negatively, such that mathematics is perceived to be 'difficult, cold, abstract, and in many cultures, largely masculine" (Ernest, 1996, p.802). Others describe mathematics as 'fixed, immutable, external, intractable and uncreative' or 'a timed –test' (Buxton, 1981). "Some students would prefer to have a dentist drill their teeth than to sit through a math class. Others view math class as a necessary but evil part of getting through school. Still others enjoy playing and working with numbers and problems" (Gutstein & Peterson, 2005).

I think that I should agree with Frieda that math is often taught in ways divorced from the real world. I agree also with Sam (1999) that mathematics is perceived negatively not only in developed countries but also in developing and under-developed countries. I also agree with Ernest (1996) that mathematics is taken

as difficult, cold, abstract and masculine. I should agree with Gutstein and Peterson (2005) that some students perceive mathematics as an awful subject and that it seems to have no compassion in them.

I think that these are stories created by our school system, our education system, our teaching and learning methods and our old outdated pedagogy of mathematics. I did not find any good examples from my everyday life and the same for my friends. The above examples show that there was lots of mathematics in our day-to-day lives but it is surprising why they were not incorporated into our school mathematics. As far as I am concerned, I was interested in mathematics but there was no life in the learning of mathematics in those days. The subject was purely theoretical, dry and of no interest for learning further except as an academic compulsion to study the subject.

Mathematics learning and practice in school and out of school differ in some significant ways. Some of these differences may be inherent because a concept is learned and used differently in school than that out of school. However, we believe that many of the differences can be narrowed by creating experiences that engage students in doing mathematics in school ways similar to mathematics learning and practice outside school.

The framework Saxe (1991) outlined for interplay between sociocultural and cognitive developmental processes targets cultural practices as important contexts for study. How more and deliberate interplay can be encouraged between these developmental processes by focusing on mathematics learning and practices in everyday contexts as starting points. We believe that making in-school and out-of-school mathematics experiences more complementary, student learning and practice

in both of these situations can be enhanced (Masingila, Davidenko, Wisniowska & Agwu, 1994).

Connecting in-school with out-of-school experiences. First, in order to create in school experiences similar to out-of-school experiences, the goal structures of activities must be similar to in-school and out-of-school activities from which students may construct similar mathematical knowledge (Masingila, Davidenko, Wisniowska & Agwu, 1994). Masingila, Davidenko, Wisniowska and Agwu (1994) further state this means that the curricula include a wide variety of problems in out-of-school situations. Thus problems are embedded in situations that are real and meaningful to students, and mathematics practice can be structured in relation to these problematic situations. In my understanding it also means that mathematics is a tool to be used and that procedures and processes are learned as they are needed in the midst of accomplishing emerging goals.

According to Masingila, Davidenko, Wisniowska and Agwu (1994), teaching via problem solving deviates from the traditional instructional approach of the teacher presenting information and then assigning exercises in which students practice and apply the information. Using a teaching via problem solving instructional approach means that mathematical understanding are constructed by students as they seek to accomplish emerging goals through problematic situations (p. 13).

I agree that social interactions are an essential part of this classroom mathematics practice. In working individually and collectively to accomplish emerging goals, mathematics knowledge is developed within a meaningful context and cognitive development occurs as students work together in peers and teacher to negotiate shared meanings. As Saxe (1991) noted, social interaction is a key influence on the emerging goals of an activity.

For me, in-school activities should make use of cultural artifacts and conventions that students can use to interpret problems and make sense of them. For example: students can collect some cultural artifacts such as *'nanglo, doko, ghanta, perungo, thunse, gagri etc'* and discuss in the classroom teaching and learning about how these artifacts relate to mathematical concepts. Students should also be encouraged to generate conventions that may be helpful to them in the course of accomplishing their emerging goals.

It is believed that teachers can build on students' prior understandings. All students bring to school mathematical knowledge acquired in other contexts. This knowledge is often hidden and unused by students in school as learn to use mathematical procedures that teachers demonstrate and evaluate (Mashingila, 1993a). If teachers engage students in conversation about their everyday experiences, listen to them, and encourage and observe their informal methods of mathematizing, they can learn much about students' prior understandings. Similarly, teachers can encourage students to bring to bear their prior understandings by having students: (a) create their own problem situations, (b) solve problems in more than one way and share their solution methods with each other (Lester, 1989), and (c) focus on semantics rather than syntax (Masingila, Davidenko, Wisniowska & Agwu, 1994).

Connecting out-of-school with in-school experiences. Besides creating experiences in school that may complement out-of-school mathematics learning and practice, teachers can guide students in reflecting on how in-school learning and practice are used out of school (Masingila, Davidenko, Wisniowska & Agwu, 1994). In a study examining middle school students' ideas about their out-of-school mathematics practice, Masingila (1994) observed that with encouraged reflection students were able to note a number of ways that they used mathematics outside of

school. Sixth and Eighth grade students were interviewed before and after keeping a log for a week in which they recorded their use of mathematics. Although, students reported ways they used mathematics they classified as 'non-school math', they also indicated many instances where they used knowledge they categorized as 'school math'.

Masingila, Davidenko, Wisniowska and Agwu (1994) suggest that an important aspect of in-school mathematics experiences becoming more complementary is to encourage students to be aware of their mathematics learning and practice outside of school. This involves having students discuss their out-of-school experiences and what mathematics concepts and processes they used in those experiences.

Additionally, to me, teachers can have students reflect on how their in-school mathematical experiences influence this learning and practice. Teachers can also ask students to think of out-of-school experiences that are similar in some aspects to mathematical problem situations they have encountered in classroom. Students and teachers can have a good discussion concerning similarities and differences between these situations that can help students to see the value of mathematics practice in both contexts.

According to Masingila, Davidenko, Wisniowska and Agwu (1994) both in-school and out-of-school experiences, students participating in mathematics practice will become engaged with novel mathematics goals that require form-function shift. Teachers who observe these gradual and complex shifts, gain valuable assessment information about students and can serve to facilitate the process of students acquiring mathematical knowledge to use as cognitive tools.

In my learning of out-of-school mathematics linked with in-school mathematics were measurement of weight of sugar, rice and vegetables, volume of kerosene and mustard oil at the nearby grocery, length and width of flower garden at my home, cost of my living out of home during exam time and other day-to-day application of mathematics. But it was all naturally transferred mathematics from in-school to out-of-school practices. The school system and society did not put their effort in this transfer of mathematical concepts and ideas to and from school and society.

Contextualization of Mathematics

As Gutstein and Peterson (2005) have claimed, to help students to understand their lives in relation to their surroundings and to see math as a tool to help make the world a more equal and just place, can be equally applicable in our context too. It seems to me that our school system is more traditional or conventional than those of the West and there are many more social, cultural, economic and political injustices in our mathematics curriculum and classroom teaching and learning processes. I think we have hundreds of mathematics experiences in our day-to-day lives. However our school mathematics has rarely addressed such day-to-day life cases and experiences of students and teachers.

Our mathematics teacher was more traditional than our “Family Pundit” and so he taught mathematics in the way he liked; and there was no dialogue, sharing or group work in the class. Our teacher thought himself as having the supreme power in the class. Corporal punishment in mathematics class was synonymous to teaching. Even today my colleagues at that time are scared to remember the dark days of their

early school life. I think this was not only the situation in our class. It might have happened in other schools too.

"In a rethought math class, teachers make mathematics more lively, accessible, and personally meaningful for students, who in turn learn in more depth" (Gutstein & Peterson, 2005).

Who cares? We learnt the way and we apply the way. Our education system and teaching – learning ways have been so traditional that it may take a lot of time to bring about changes. Gutstein and Peterson (2005) have mentioned about the new possibility in teaching and learning of mathematics, but it is far away from our context.

However, I should not be so pessimistic. We have done a lot in recent times. Thousands of teachers have been trained and the government has revised the school mathematics curriculum and the process is on the way to improving the mathematics curriculum. It is time to rethink our mathematics, from school level to higher level, in order to make our mathematics more contextual, relevant and practical.

"Students can recognize the power of mathematics as an essential analytical tool to understand and potentially change the world, rather than merely regarding math as a collection of disconnected rules to be rotely memorized and regurgitated" (Gutstein & Peterson, 2005). The practice of teaching and learning of mathematics changes as per the context, relevancy and more dynamic way, our students will be more able to recognize the power of mathematics as an essential analytical tool to understand our GDP, GNP, Per Capita Income, and National Budget in Security and Education. Their study of percentage will be more meaningful if they will start analyzing what percent of people enjoy 80% or more of the national production. "Students can deepen their understanding of important social issues such as racism

and sexism, as well as ecology and social class" (Gutstein & Peterson, 2005). Certainly our mathematics is so sterilized that not our students, but we mathematics educators, as well are not critical about racism, sexism, economic, environmental and other social issues in our country and throughout the world. What mathematics we studied and what mathematics we are teaching should be a matter of rethinking at least for our future generations.

I agree with Gutstein and Peterson (2005) that students can connect math with their own cultural and community histories and can appreciate the contributions that various cultures and people have made to mathematics. Why students are not taught the glorious history of mathematics and the contributions of mathematicians? The connection of mathematics with culture, history and social practices can help students to realize the value of mathematics, enjoy the aesthetic aspect of mathematics and apply mathematics in daily life and bring daily life cases into the mathematics classroom. Why there was no connection of how many 'twenties' I paid for a chicken in my school mathematics? Why there was no mention about measurement of fine amount of gold using local unit 'Laal' or standard unit 'grams'? These are the reasons that I think people consider mathematics as difficult, cold, abstract and masculine, as stated by Ernest (1996).

To me, students can understand their own power as active citizens in building a democratic society and become equipped to play a more active role in that society (Gutstein & Peterson, 2005) and the example is always in front of us. I, even today, remember that we had kept a bleu flag in front of a wooden toy motor and shouted slogans "long live multi party democracy" in the national referendum of 2036 B.S. Our school system was always on the side of protecting the feudal system of the Panchayat. We learnt the slogans from our elders and we did as we liked and as we

saw others doing at the moment. This shows that children learn from society and children learn from other members of society too, except the school system. But the point is that if the school system recognizes the context of teaching mathematics in the classroom that means a lot for the students and that becomes really meaningful learning, contextual learning and learning math for social justice and equity.

So far as I have understood, Gutstein and Peterson, (2005) are right to state that benefits of the learning and teaching of mathematics in a critical way come both when teachers reshape the mathematics curriculum with a social justice vision and when they integrate social justice mathematics across the curriculum into other subjects, such as social studies, science, health, reading, and writing. I learnt mathematics in an isolated way. I did not learn the role of mathematics in my society, I did not learn the role of mathematics in the social system, I did not get the chance to learn mathematics for analyzing social injustice and inequity in society. I don't think our education system let any student think critically on these issues.

Situating Mathematics in Culture

Prakash was the son of a rich landlord and Sudan was the son of farm laborer. Both of them represented students from diverse economic classes. We studied in the same class. Our mathematics never tried to help us analyze our social system. I think the mathematics we studied was to maintain the status quo in the society and it seemed neutral to the social, economic and cultural aspects of the students. That led us to fall behind in the social, economic and other aspects of the national development. If the mathematics class had been with a live with analyses of our social and political context, perhaps we would not be facing the grave situation at the present. My reflection on the mathematics at the time seems biased as I did not find

anything that I learnt to analyze and think critically at the time. My mind, my thinking and my vision was fully paralyzed and favored the status quo. My practice of teaching mathematics too remained the same as the way I have learnt it.

It seems to me that mathematics is essential to more than a surface understanding of important social and political issues (Gutstein & Peterson, 2005). It was surprising that there was no learning of how to buy and sell goods in our mathematics. There was no dialogue as seller and buyer. There was no dialogue about earning and losing money in a social context. In every 'Dashain' and 'Tihar', I used to play cards and *cauda* (a gambling game played with the shell of a certain mollusk). But I did not find any such issues in my school mathematics. There were no such cases of chance, probability or games in the school mathematics. I used to coordinate village people to clean the local water well and streets during festivals but I never learnt how to estimate time and cost for the local projects.

My learning of arithmetic was limited to numbers and purely bookish numbers, my algebra was limited to variables in the exercises and it never exemplified social and cultural issues. My geometry was limited to measurement and construction in the notebook from the textbook and it never correlated with my local project of cleaning the road, or the construction of *chautaro* (resting place under a tree) and local bridges. I think that it was the politics of the then politicians to put people in the dark and maintain the status quo of the society. It may be that the same will happen to us and we will be blamed by our future generations if we do not learn from the times, contexts and needs of our society. Mathematics should serve as an eye of the society in seeing the world, it should be a tool of society for analyzing the social justice and equity, and it should be a way of living, the practice of democracy starting in our classrooms.

Every year, our government announces its national budget. Percentages are separated for development, education, health, and other social sectors. I think we never bring it in to our classroom. To me, it should be a politics in the classroom. No teacher and no student can remain unbiased about social, economic and political issues. Then why does the mathematics class not incorporate the government's budget, the impact of war, the meaning of national debt, or the long-term effects of proposals such as the privatization of Social Security (Gutstein & Peterson, 2005), expenses of political institutions and constitutional bodies? So, the situation has been grave and we are to be blamed by our future generations.

We talk about tax and VAT in arithmetic class in the secondary level mathematics. Why don't we talk about ill practices such as commissions that people have to pay? Why don't we talk about bribery and other corrupt practices in the mathematics classroom? Why don't we bring our social goods and ills into the mathematical context and in the classroom practice so that our students will become more critical analyzers, creative thinkers and become aware and responsible citizens of tomorrow? I could not learn such things from my mathematics class but I am now on the way to learning by teaching theses issues in my current mathematics class. Certainly it will be difficult at the beginning but time and context will favor me and my generation to be safe in the future.

I think that the same is true with other social, ecological, and cultural issues: one needs mathematics to have a deep grasp of the influence of advertising on children; the level of pollutants in the water, air, and soil; and the change of the chemicals in the food we eat (Gutstein & Peterson, 2005). Math helps students to understand these issues, to see them in ways that are impossible without math; for example, by visually displaying data in graphs that otherwise might be

incomprehensible or seemingly meaningless. I learnt in my mathematics class how to present numerical data in charts or graphs but I did not learn their meaning in our social and political context. My learning at the time was objective, neutral and purely bookish. We did not discuss any such social, ecological and cultural issues in the class. So, my learning of mathematics in my school days was to be able to reproduce what my teachers taught and to write the same during exams. Exam… Exam…. Exam… all the time learning was centered to exam. There was no mathematics in the classroom outside the sphere of the exam. The same is the case even today when I go to teach mathematics to grade ten students. Even when I try to bring some issues into the classroom, the school administration says it is out of the course, students say it does not come in the exam.

Mathematics and Social Justice

I agree with Gutstein and Peterson (2005) that when teachers weave social justice into the math curriculum and promote social justice math across the curriculum, students understanding of important social matters deepens. This is essential element in a democratic education system. But it always remained far from practice in our context. When I tried to speak with the mathematics teacher while he was writing on the board, I was nearly slapped instead of getting encouragement. Once my friend Bharat was discussing a mathematics problem with his peer at the same bench, the teacher slapped both of them in such a way that they could not come to school for few days. What power the teacher had! What control the teacher had! We were all silent in the class. Speaking was guilt and to discuss with a teacher was against the school discipline, even when the teacher was wrong. Then who, did not say mathematics was boring, mathematics was hard and mathematics was painful.

As a responsible teacher, educator and citizen, I think teaching mathematics in a neutral manner is not desirable at the present context. No mathematics teaching – no teaching of any kind, for that matter – is actually 'neutral' although some teachers may be unaware of this. As historian Howard Zinn once wrote: in a world where justice is mal-distributed, there is no such thing as a neutral or representative recapitulation of the facts (Gutstein & Peterson, 2005, p.6). I think that at the moment the problem is deeper than a sterile teacher-centered and text-driven approach. 'Number numbness' also has its roots in how math is segregated in schools and kept separate from the issues that confront students in their daily lives. It seems to me that most students don't want to do abstract exercises with numbers or plod through text-based story problems that have them forever making change in some make-believe store (Peterson, 2005).

In my understanding rethinking math also means using culturally relevant practices that build on the knowledge and experiences of students and their communities (Gutstein & Peterson, 2005). We should be on the way to bringing changes to school and university mathematics that can be socially, culturally and politically relevant. It is the essence of the time otherwise we will be blamed, and it is certain that in the future if we do not work on it at present, it will be as though we did not do it in the past. So, rethinking math should be a new way of realizing mathematics in an integrated form but not in an isolated form. Mathematics should not be blind to the social, economic and political contexts in the country. From the viewpoint of responsible citizenship, creative and critical thinking citizenship, mathematics should not be as I learnt it and it should not be as I taught it but it should be as I am now teaching and will be teaching.

So far as I have understood, a guiding principle behind much of this work is that teachers should view students' home cultures and languages as strengths upon which to build, rather than as deficits for which to compensate. As students develop deeper understanding of social and ecological problems that we face, they also often recognize the importance of acting on their beliefs. This notion of nurturing is what Henry Giroux has called 'civic courage' – acting as if we live in a democracy – and should be a part of all educational settings, including mathematics classrooms (Gutstein & Peterson, 2005). Then only will there be integration of informal mathematics in the school classrooms as a ground for learning formal or academic mathematics. I think that engaging students in mathematics within social justice contexts increases students' interest in math and also helps them learn important mathematics (Gutstein & Peterson, 2005).

Contextualized Math Curriculum

Luitel and Taylor (2003) have rightly stated in the context of Nepal that critiquing the existing sociology of Nepali mathematics education has unfolded a range of anomalies prevailing in the field. Viewed from a critical perspective, these anomalies include culturally decontextualised curricula and pedagogy, asymmetrical power relationships between the agents involved in the curriculum process (i.e., curriculum experts, teachers and students), hierarchical communicative classroom contexts, and teacher-centered classrooms. In saying this, we are not arguing that these are the only anomalies responsible for culturally dislocated mathematics education. Instead we believe, according to Bal Chandra's experience as a student, a teacher and a teacher educator, that such anomalies restrained his own learning in a

way that can be envisaged as mathematics serving the goal of imparting only technical knowledge rather than emancipating with life-affirming goals.

I am in perfect agreement when Luitel and Taylor (2003) argue that the contextualization of mathematics education is essential in order to promote a pluralistic mathematics education and to value non-Western corpora of knowledge traditions for developing a justifiable mathematics education. I think our mathematics teaching and learning is not able to capture the very personal, social, cultural and political issues. So, I think Luitel and Taylor (2003) rightly further state that, at the same time, we should contest the idea that mathematical knowledge is transcendental; arguing that politics, values and interests guide pedagogical selection of learning experiences. I am convinced that, epistemologically, we are situated in a position that embraces a transformative view of learning as a process of cultural meaning making (Luitel & Taylor, 2003).

I think that many of our own social justice projects should start from conversations with students about their lives or from knowing about issues in their communities (Gutstein & Peterson, 2005) so that our students take mathematics as an important subject and so that they will show more interest. For this, I think that the media can also be a potential source of projects, because current issues both affect students' lives and have mathematical components that teachers can develop into social justice projects. For this, I think likewise a text-driven, teacher-centered approach does not foster the kind of questioning and reflection that should take place in all classrooms, including those where math is studied (Gutstein & Peterson, 2005) for the improvement of mathematics achievement in our schools.

Again, I remember Luitel and Taylor (2003) stating, "*Don't forget your landscape* is a popular Nepali adage used often to remind others about their

background. Specifically, the adage is used to advise persons with an improved lifestyle resulting from formal education not to deviate from their cultural capital by which they are linked with their land". I think our landscape encompasses our social, cultural, geographical, demographic, economic and political dimensions that have formed Nepal and we feel the glory of saying that we are Nepali. We should link our mathematics education from school level to university with our context without deviating from the global context and without losing the rigor of learning mathematics. That is, we need to explore the notion of contextualizing mathematics education through both our experiential and theoretical landscapes (Luitel & Taylor, 2005).

"A strong conceptually based foundational curriculum can be a great asset to social justice math teaching, because it can encourage students to critique answers, question assumptions, and justify reasoning. These are all important dispositions toward knowledge that teachers can integrate into their social justice pedagogy" (Gutstein & Peterson, 2005). It's not something about which we should feel defensive. What we can think about here is something that helps students learn rich mathematics, motivates them, and is really what math is all about.

Luitel and Taylor (2003) state, "In our experience, dealing with the issue of cultural contextualization requires us to crystallize its notion in accordance with the goals and the process of contextualization." I think that the mathematics I learnt in school and college was not contextualized according to social, cultural, economic and political context and it was more Indo-Westo centric. Even the practice today has not been much improved and we are on the verge of wiping out our own cultural capital from the point of view of socio-culturally critical mathematics.

I think there is wide range of possible levels of contextualization of school and college mathematics in Nepal. According to Luitel and Taylor (2003) looking at a range of literature (Abreu, 2002; Pinxten, 1994; Skovsmose, 1994) gives us a glimpse of a range of possible levels of contextualization of mathematics education. In our perspective, they can be categorized as teacher, school, content, pedagogy and curriculum development levels (Luitel & Taylor, 2003). I think the case of teacher level contextualization may depend upon the teacher being enthusiastic to contextualize mathematics curriculum in his/her teaching areas but he or she needs such exposure through training, workshops and seminars. In the same manner, I feel that schools, too, can implement or be selected to implement mini-projects on the cultural contextualization of mathematics education. In order to promote socio-cultural contextualization of mathematics education certain content areas can be linked with local socio-cultural aspects. Not only socio-cultural aspects, the contextualization should be linked with economic and political contexts too so that students can play an active citizenry role.

According to Luitel and Taylor (2003) contextualization at the pedagogy level requires us to understand mathematics as a subculture that comes from a discourse community and contemporary society. Perhaps, determining contextualized pedagogy also requires contextualized language, media, communicative codes and so forth. Mathematics comes from contemporary society as a product of socio-cultural, economic and political intervention and compromization. I think the mathematics I studied was uncontextualised and still the mathematics I am teaching is also uncontextualised, but to me, it’s time to think about contextualized school mathematics curriculum, teaching and learning, pedagogical practices and teacher education or training too.

Pedagogy of School Math

I think Tate (2005) is right to state that the teaching of mathematics needs to be connected to the lives and experiences of students to enable them to fully take part in our democracy. Traditionally, schools have not provided students opportunities to do so. Mathematics teachers should bring the cases of students and their life experiences in classroom discussion for more understanding and meaningful learning of mathematics. Mathematics of farm lands, mathematics of poultry farms and animal husbandry, mathematics of shopkeepers, mathematics of tailors and shoemakers, mathematics of ironsmith to goldsmith, mathematics of housewives to children playing in groups should be incorporated in classroom learning of mathematics. I think this is possible in a flexible and open curriculum of school mathematics.

One important implication of Woodson's argument is that mathematics instruction that is built on a student's life experience provides two mathematics-learning environments: within the school and outside the school. Unfortunately, the disciplines that under-gird mathematics education – mathematics and pedagogy – place great stress on objectivity and neutrality. As a result, school mathematics has been tacitly accepted as a color-blind discipline. Thus very little consideration is give to the cultural appropriateness of mathematics pedagogy (Tate, 2005).

What type of pedagogy must indigenous students negotiate to be successful in school mathematics? Conventional mathematics pedagogy emphasizes whole-class instruction, with teachers modeling a method of solving a problem and students listening to the explanation. This is typically followed by having the students work alone on a set of problems from a textbook or worksheet. The goal of this teacher-directed model of instruction is for students to produce correct responses to a

narrowly prescribed problem. I think, this type of mathematics pedagogy is consistent with several studies of mathematics instruction conducted in the 1970s (Tate, 2005).

It seems that unfortunately this conventional mathematics pedagogy is exactly the kind of 'foreign method' of teaching described by Woodson. Few if any attempts are made to build on the thinking and experiences of students (Tate, 2005). I think one important purpose of mathematics education is to prepare students to incorporate mathematical reasoning and communication into their everyday lives. However, conventional pedagogy has often persuaded students – particularly indigenous students – to consider school mathematics as a subject divorced from their everyday experiences and from their attempts to make sense of their world (Tate, 2005).

"In order to take advantage of the diversity in a single classroom, a mathematics teacher's pedagogy should try to provide students with opportunities to solve problems using their experiences. Of course, the mathematical processes used to solve problems should be consistent with the contexts of students' lives. Furthermore, mathematics teachers working from a centric perspective would endorse having their students solve the same problem from the perspective of different members of the class, school, and society. This approach is consistent with the methods of successful teachers of African-American children" (Tate, 2005).

Conflict, Democracy and Pedagogy

I think that when there are more ideas and perspectives competing with each other, and then conflict is natural. In democratic organizations and practices conflict is usually based upon a difference over goals, objectives, or experiences between individuals or groups. Conflict also occurs when two or more people, or groups, compete over limited resources and/or perceived, or actual incompatible goals. At the

same time, such conflicting ideas and the democratic environment affect pedagogical practices. So, to me conflict is in the child when he/she is learning mathematics in and out of school. Interpersonal and intrapersonal conflict motivates a child to learn mathematics through interactions with elders, parents and peers. In my understanding, the pedagogical practices in schools should be directed towards critical and creative thinking so that they can adjust themselves in conflicting environments through democratic practices.

Tate (2005) states that a barrier to providing an equitable mathematics education for African-American students is the failure to prepare them for the conflicts of democracy (Tate, 2005). The case is applicable in our context to provide an equitable mathematics education for indigenous students in the public and private institutions. We have not yet prepared our students for the conflicts of democracy in the classroom and outside. I have not a single example of students getting involved in mathematics class discussion to understand conflicting ideas. Teachers teach the ideas as transmitters and students receive as taken-for-granted without argument, without counter argument and without a feeling of the critical and analytical aspects.

"The study of the particular way that specific cultural or ethno groups-whether they are different national, ethnic, linguistic, age or occupational groups or subgroups – go about the task of classifying, ordering, counting, measuring, and otherwise mathematizing their environment is called Ethnomathemaitcs" (Franco, 2005). I think the integration into school mathematics of ethnic mathematics is important for both political and mathematical reasons. The teaching of the mathematical traditions of different ethnicities and cultures can contribute to achieving a crucial political goal: infusing multiculturalism into education. For me, students will thereby develop an appreciation for the diverse ways different cultures

understand and perform mathematical tasks. So, I feel that this will expose students to the sophisticated mathematical traditions of other cultures and demonstrate that performing mathematics is a universal human activity (Franco, 2005). I think integrated approach with the study of various mathematical practices people can do much to instill pride in their culture and also increase their confidence in their ability to learn and do mathematics and, perhaps, later participate in mathematics-based careers (Franco, 2005).

Epilogue

The vignette in my poetry in the introduction chapter depicts how I learnt mathematics before school in my early childhood. The parallels of learning mathematics informally and formally should meet at a finite point (at school) but in the present system of teaching and learning mathematics they tend to meet at infinity. The main reason I think is the lack of incorporation of informal mathematics in academic mathematics. When the boundaries of the two blur, there will be values-based, culturally rich and contextual teaching and learning of mathematics. My educative process from traditionalism to constructivism has motivated me to work in a way that will enable me to incorporate ethnomathemaitcs (cultural mathematics) into my pedagogical metamorphosis. The reference of observing Anjilla playing with her toy-car, the cosmic dance of Lord Shiva, paying “four twenties” for a chicken, and weighing gold with red seeds all signify the portrayal of my pedagogic metamorphosis, either directly or indirectly.

It seems to me that informal mathematics of day-to-day life provides a strong foundation for the meaningful learning of mathematics if pedagogic practices are transformed from conventional to critical approaches bridging through ethnomathemaitcs. Bridging in-school mathematics with out-of-school mathematics is an essential task in the present curriculum practices that makes mathematics more applicable, easy to understand and interesting to school children.

CHAPTER 3

COOPERATIVE LEARNING: MY DYNAMICS OF LEARNING MATHEMATICS

In this chapter I have explored the idea of group learning and its benefits. There are many methods and strategies of teaching and learning mathematics. Some of them are: collaborative learning, cooperative learning, discovery based learning, engaged learning, and problem based learning. I have tried to reflect on my past memories and nodal events in my learning mathematics. I found cooperative learning in a small group to be a very effective method from school to university level. Although I was not aware of the word cooperative learning at the time, I was involved in group work; cooperative learning took place within classes less or so and outside more or so, consciously or unconsciously.

My Journey of Cooperative Learning

From the very beginning of my school life I started learning mathematics in-groups. Though I could count from one to hundred, I was poor at writing number. One of my friends, Gir Bahadur, was good at writing these numbers. I requested him to help me and he agreed. We used to sit together on the same bench. On my first day of school, I learnt how to write “EK and Dui” with the help of my friend, Gir Bahadur. Slowly I became familiar with other boys and girls in the class. We formed a team to sit together. When there was a pare period in the school we used to practise mathematics together in group. We learnt from each other in a group.

Our mathematics teacher often came in last period and told us to count from one to a hundred in turn by turn standing at the front of the class. Then he gave us

writing work. I had a small slate board in my bag and wrote on it with a clay chalk. My friend, Gir Bahadur, helped me a lot to be able to write from one to a hundred. He also taught me multiplication table from two to ten. We formed our learning team. There was no initiation of teachers to form other such groups. If that had happened, there would be more learning of mathematics and classroom learning of mathematics would be cooperative learning. But I can say that at least there was cooperative learning in my informal group of learning of mathematics. Not only in grade one, it continued in grade two, grade three and others too. My cooperative learning was the main dynamic of my learning of mathematics. It started on the first day of my school and lasted until the end of my graduation. So, cooperative learning was the main dynamic of my learning of mathematics in the past and it is equally applicable to the present as well.

What is cooperative learning? How does cooperative learning help students to learn mathematics? What are the basic elements of cooperative learning? What are the different types of cooperative learning? To what extent can cooperative learning help students build social relationships, learn from each other, share responsibility, and solve their problems in a group?

These are some of the key questions that I explore in this chapter. Although the school system had not incorporated a cooperative learning, how students themselves created learning in cooperative groups and shared their ideas, opinions and knowledge in a responsible manner has been explored from my experiences.

Episodes of Cooperative Learning

The following few episodes give an idea about how I practised informal cooperative learning of mathematics from school to university level.

Episode – one. It is evening. Some boys gather at a room in Shashi's home. They are going to do their mathematics homework. They open their bags and every one is ready with a book, a notebook and a pen.

Kul Raj (opening up the maths book): Let's start our practice from the beginning.

Madhav: No, lets practice the difficult ones.

Bharat: Let's start from simplification.

(Shyam and Madhav remain silent for a while)

Smoky cloud from the west is moving to the east as if it has to reach its destination within a few hours and it has no time to wait and look downward. The sound of a thunderstorm in the western horizon makes us cautious about the weather conditions. We need to finish the day's homework and prepare for examination. It must be at 8.30 p.m. on a summer day in 1983; I am among my friends Bharat, Kul Raj, Madhav and Shyam in my study room. The first terminal examination is near. Where to start from is a problem for the evening. We discuss how to start our practice.

I (seeking their consent): If you agree, let's do what Madhav says.

Kul Raj (opposing): How can you say which is difficult for me and which is difficult for Madhav?

I (closing the discussion): Okay, let's start from the beginning. It will cover all.

All of us agreed.

We started practice of mathematics from the beginning of the mathematics exercises from the textbook of grade six.

One of the problems was like this: $\frac{2}{3}+\frac{4}{5}$, Bharat did as follows: $\frac{2}{3}+\frac{4}{5}=\frac{2+4}{3+5}=\frac{6}{8}$.

Kul Raj (frowning at Bharat): It's wrong.

Madhav (pointing at Kul Raj): It's correct.

Shyam (turning the copy to me): Shashidhar, you tell us whether it is right or wrong.

I (after looking at the answer): Let me do it myself and then I will tell you.

Kul Raj (turning his copy up and holding pen with right hand): I will also do with Shashidhar.

Madhav: I see the next problem.

I (After few minutes): Friends, this is the solution: $\frac{2}{3}+\frac{4}{5}=$

$$\frac{2}{3}.\frac{5}{5}+\frac{4}{5}.\frac{3}{3}=\frac{10}{15}+\frac{12}{15}=\frac{10+12}{15}=\frac{22}{15}$$

Kul Raj (turning to last pages of the book): Yes, it's correct.

Shyam and Madhav also agree that it is correct. But Bharat is still in the opposite. I try to convince him about why it is necessary to multiply by 5/5 and 3/3. He comes to a compromise saying that he will do the next one and see the answer in the same way.

We five boys from the same class stay till twelve of midnight. There is discussion and sharing of ideas among us. Nobody can go ahead without making everyone satisfied. We sometimes divide our responsibility to prepare different chapters and discuss together. We five boys have good unity in the school and it is a unique way to learn mathematics and other subjects in the school. We are open to teach and learn each other. As the thunderstorm and lightening become more vigorous, we put the lantern out and go to our bed. At the same moment a loud thunderstorm rumbled in the sky makes us afraid and so we hide ourselves in our bed.

Episode – Two. There is a good friendship among the boys though they have different habits. One morning at seven o'clock in the Spring of 1988, the boys go on to the rooftop of the hostel to practise mathematics. They divide the task among them for a few days for cooperative learning (in their words, combined study).

Mahesh chooses algebraic simplification. His part is to practise simplification from algebra and teach the other members of the group. Prakash chooses simultaneous equations for his part and Bishnu chooses profit and loss from the arithmetic portion. Tham chooses geometric theorems and Shashi chooses geometric constructions for his part. The boys have to prepare for their lessons to teach from the next day to the other members of the group.

Next morning all the team members gather on the rooftop. Each member has to spend half an hour to teach others the topic. Mahesh starts first to teach the group the simplifications of algebraic fractions. Other members put some questions to him for more clarification. He tries his best to satisfy them. Tham is good at algebra and .So, he cooperates Mahesh to clarify. He then promises to continue the remaining problems the other day.

It is now the turn of Prakash but he says he will do his part at the last. Bishnu comes forward to start teaching his group members. He starts the concept of profit, loss, selling price, cost price, and profit and loss percent. He also deals with discount and sales tax. Then he starts with problem solving. We all enjoy the problem solving. But he cannot do more problems solving due to shortage of time. He also keeps some problems for next day. Next is the turn of Tham. Tham starts with some basic definitions, axioms and postulates in geometry. Then he starts with a simple theorem concerned with congruent triangles. His teaching is over with one theorem. He makes the basics of geometry so clear to us that it is so much clearer than in class.

Then Shashi starts his geometric construction. He tells all group members to be ready with a compass, pencil, ruler and protractor. He at first starts with construction of simple triangles with given information. Then he starts construction of triangle in which perimeter and two angles are given. The group members enjoy the construction of the triangles. Lastly, Prakash comes up with idea of solving word problems in simultaneous equations of two variables. He does his best to make other members understand the nature of problems and formulate appropriate equations. He demonstrates two examples. Then the time is over. It is already nine o'clock in the

morning. They promise to sit for discussion next day and depart for breakfast and then go to school.

They make a rule for the group members. The group members have to teach for half an hour each day in the area each has selected. The group members should inform if they cannot prepare certain lesson on time. The five boys have set a good example of cooperation in the learning process. Others also try to do the same but they cannot coordinate or form a group like theirs. They have diverse interests, attitudes and ambitions but they are honest in the group work. So the group work continues throughout the year. Later Tham becomes seriously ill and his health is weakened. So, he cannot contribute as he is supposed to do but the group members enjoy his support in the group till the final examination of the year. All group members pass with good marks in the final examination. The group learning helps them a lot to improve in their mathematics and other subjects as well. Though there is no cooperative learning environment in the classroom teaching and learning, the boys do the group work with their own idea for mutual sharing and help. Certainly it is an example of cooperative learning in a group.

Episode – Three. Tuk.. Tuk…/ Tuk.. Tuk…/ A gentle knock on the door.

The door opens.

Ujjwal: Hello, Krishna Ji, how are you?

Krishna: Fine, thank you; and how are you?

Ujjwal: Fine, thank you.

Krishna: How is your study going on?

Ujjwal: You know it. I am not getting Operations Research well.

Krishna: Same is for me. I came to you for combined study.

Ujjwal: Oh! That's a good idea. But Sujit wants to join us.

Krishna: That's good. Let's call him here now.

Ujjwal: No, let's go to him and make our study plan.

(Krishna and Ujjwal go to visit Sujit in his office)

Ujjwal: Excuse me.

Sujit: Hello Ujjwal and Krishna Ji, please come in.

(Ujjwal and Krishna enter the office, after a warm handshake Sujit shows them the vacant chairs opposite him and says) Please be seated.

Krishna (after taking his seat): We have come to make a study plan with you.

Sujit: It's good of you to remember me. I am in need of your help. I can not go to private tuition. The fee is very high and the tutor simply gives notes and does not explain well.

Ujjwal: Then what time are you free? Should we come here or you will come.

Sujit: It will be fine if you can come here. I don't have much work here.

Krishna: O.K. Let us divide the chapters.

Ujjwal (looking in a book): I will take Linear Programming.

Sujit: I will work on Game Theory.

Krishna: I will prepare for Queuing Theory.

Ujjwal: Sujit Ji, let us go for today. We will meet tomorrow with our parts.

Sujit: You can not leave without having a cup of tea.

(He presses the bell. Cring …Cring…)

Office Helper: Yes.

Sujit: Bring three cups of tea as soon as possible.

Office Helper: O.K. I will bring.

The three men talk about their preparation in different subjects. They also discuss about other courses. The helper brings tea and serves them. After a while they depart. This dialogue does not have any cooperative learning of mathematics but it portrays how a dynamic group is formed and how it can be a model of cooperative

learning. It is really the way that group interacts and forms a cooperative group ready share responsibility.

Episode – Four. It could be a rainy day of 1998. Four men gather in one room in the Office of Teachers' Records with a view to do combined study on "Operations Research". Ajay is a new member in the group. Ujjwal starts to discuss on the topic Linear Programming. He at first asks his friends what they know about Linear Programming. Sujit says that he does not have any idea about it. Krishna says the professor did not solve any problem for them. "The professor, Mr. Write, came up in the class with a photocopied note and handed it over to us for copying." Krishna explains how their class in the university campus is taught.

Ujjwal starts from the graph of linear algebraic system and inequality. Then he draws a graph for inequalities such as $x + y \leq 5$, $2x - y \leq 1$, $x \geq 0$ and $y \geq 0$. He discusses the common solution set for all the inequalities in the graph. Krishna, Sujit and Ajay all draw a graph for the inequalities. Then all of them discuss about the vertices of the feasible region. They determine the value of the objective function $\max.(z) = 3x + 6y$ in those vertices and discuss about the maximum of the function. In this way they reach a conclusion that they can solve any Linear Programming problem by graphical method. Ujjwal says that he will start simplex method of solving Linear Programming next day.

(The office helper brings four cups of black tea and serves them)

Sujit comes up with his preparation in game theory. He starts with questions: What is a game? What are the types of games? What is two person zero sum game? And so on. He also discusses about some definitions such as strategy, matrix, players, and value of game, win, lose and so on. He, then, starts two persons zero sum game. He writes a matrix and starts discussion about how to solve the game. At first, he

discusses about the Saddle Point method. It is so clear to all others that they like the technique of joint study. Sujit also stops his discussion for the day after the Saddle Point method with promise to continue next day with other methods.

Now it is time for Krishna. He says that he is not well prepared for the discussion but he will be ready next day. Ajay also chooses a topic, inventory management, for the discussion next day. Krishna tells Sujit that he can not get his points about Saddle Point method of solving a game. Ujjwal comes forward and helps him to understand with next example. During the discussion Sujit supplements the points of Ujjwal.

Ujjwal tells his grief of being a tourist student among his friends. He tells his stories about how his friends do not cooperate him when he asks for a note. One of his friends teaching in the same private school does not let him read his note. He is upset with the attitude of the classmates. One of his classmates gives him the rough copy in which he has practiced some problems of Real Analysis. Krishna consoles him that the regulars are also the same as tourists. The professors do not teach well. Those who teach well leave the campus and the oldies do not take their responsibilities of teaching in the classroom.

The four men come out of the office and enter the canteen to have some snacks. They all express their view of the day's discussion and exclaim with sorrow that professors cannot do as well on the campus; otherwise they will not bother to be together.

The four men continued their cooperative learning till the end of their graduation. They found it very effective, interesting and an efficient way of learning. Though university classes were not in the process of conducting cooperative learning, the four men continued this approach as an informal cooperative group to learn mathematics.

My working in a group to learn mathematics not only encouraged me but it made my colleagues realize the power of group work even in study. Due to our continuous effort in group groups, I learnt the concept building and understanding the problem rather than rote learning. Later on, I think, this group performed better than other average students in the class.

Episode Five. Traditional learner and cooperative learner are classmates in their graduate study. The traditional learner has a good rote learning habit and cooperative learner does not have the habit of rote learning. The traditional learner is an introvert, does not like to share ideas and is a bit suspicious. The cooperative learner is open, frank and is happy to see his friend after a long time. He is more anxious to share views and ideas with his colleague. Due to their difference in study habits, they rarely share ideas and opinions in the class or outside. But today both see each other in a tea shop at Kalimati.

CL: Namaste! How are you?

TL: Namaste! Fine thank you, how are you?

CL: Fine thank you.

TL: It's so long time we have seen each other.

CL: You are too busy and don't have time to see us.

TL: No, no. It is not as you think. How is life going ?

CL: Yes, it's all right. What are you doing these days?

TL: I am preparing for the exam. What about you?

CL: I am also preparing for the exam.

TL: How is your preparation going ?

CL: I am doing well, I mean my team is doing well. How is you preparation?

TL: Do you have a team? I think it's a waste of time. I am not sure but more than seventy percent finished.

CL: It might be a waste of time for you, but I am doing well with the team.

TL: I have almost finished practicing "Higher Geometry and Analysis" and I am going to finish "History of Mathematics" within a few days.

CL: I can not rote learn the theorems. How can you do it?

TL: See, this is my analysis note. I have rote learned more than half of it. Will you ask me some theorems?

CL (Looks at the diary and asks) : Will you define a Cauchy Sequence?

TL: Sure. A sequence $\{x_n\}$ in metric space (S,d) is called a Cauchy sequence if it satisfies the following condition: For every $\in > 0$, there is an integer N such that $d(x_n, x_m) < \in$ whenever $n \geq N$ and $m \geq N$.

CL: Will you prove that "In Euclidean space $\mathbf{R^k}$ every Cauchy sequence is convergent"?

TL: Please, you look at the diary and I will state the steps. (He starts reciting..)

Let $\{x_n\}$ be a Cauchy sequence in $\mathbf{R^k}$ and let $T = \{ x_1, x_2, x_3, \ldots..\}$ be the range of the sequence. If T is finite, then all except a finite number of terms $\{x_n\}$ are equal and hence $\{x_n\}$ converges to this common value. Now suppose T is infinite. We use the Bolzano-Weiestrass theorem to show

that……

So lim $x_n = p$. This completes the proof.

CL: Wow! You did not miss a single word from your note. How can you memorize all line by line?

TL: Yea, it became my habit.

CL: Will you please teach me the theorem once?

TL: I can write all on the paper but I can not explain any more for you.

CL: I can not remember all line by line.

TL: How can you do it in the exam?

CL: I try to understand the concept, then I can do the rest in my own language.

TL: Mathematics in our own language? How is it possible?

CL: We have a cooperative group. Every alternate day we meet at a place and discuss topics. We have divided the topics among us to discuss.

TL: But I can not concentrate with others. How do you share ideas?

CL: Well. We are four in our group. Every member has the responsibility to teach a unit. We should teach as if we are in the class. We have to make everything clear. Group members can ask questions. We have to be prepared to answer from every hook and corner.

TL: That sounds good. But I think it takes time.

CL: No. It saves time. We need not prepare all the units. We simply prepare for our part only. Rest is done in group discussion.

TL: Do you use teachers' notes or hand-outs?

CL: We do not use only teachers note or hands out, but we use different books and even internet cites too.

TL: I think it's an unnecessary waste of time. Professors' hand outs are sufficient.

CL: Ok, that's your thinking. Anyway we have to do good in the exam and also learn something better.

TL: Well, its two o' clock. I must go.

CL: Will you please lend me your notes for a day so that I photocopy some of the chapters?

TL: No friend. I can not lend it to anybody. Please don't mind. It's my personal notes.

CL: Ok, it's all right. Good bye.

TL: Bye.

After two years. TL (Knocking at the door) : Hello, will you please open the door?

CL: Who is this so early in the morning?

TL: Me, Jeetu.

CL (Opening the door): Oh! Jeetu. Namaste.

TL: Namaste! Arbind. How are you?

CL: Fine thank you. And how are you?

TL: Fine thank you. I came to trouble you early in the morning.

CL: Never mind. Please what can I do for you?

TL: I have to teach a theorem to B. Ed. students. I can write it well but can not explain the second part of it. So, will you please help me?

CL: You are always welcome, my friend. I like discussing mathematics with friends. By the way which theorem are you talking about?

TL: It is, "The two angles of parallelism for a given distance are congruent and acute".

CL: It is from non-Euclidean geometry.

TL: You are right. I can say each line but can not explain the second part when we have to assume that if the angles OPS and OPR are obtuse, then all lines …….

CL: Ok, will you draw a figure for it please?

TL: Sure. (He draws a figure)

CL: What is that you could not explain?

TL: It is, “But one of them is the perpendicular through P to the line PO. It does not meet m, and again a contradiction has been reached”. This part I could not understand.

CL: Well my dear friend, it says that there can be infinite lines within angles OPR and they are intersecting lines to m. But one of the lines will be at right angles as angle OPR is obtuse. Then the line does not meet m as it is perpendicular to PO. So, it will be parallel to m. Hence it is contradiction that all lines within angle OPR intersect m.

TL: Please show me this in a figure.

CL (Pointing to the figure): Well, this is line M, say perpendicular to PO, and one of the lines within and OPR. Does it meet m at finite point?

TL: No. It is parallel to m.

CL: That is why this contradicts that all the lines within angle OPR intersect m.

TL: Now I got it. Thank you. How did you know all these ideas?

CL: I learnt by discussion with friends. Myself I learnt the concepts rather than rote learning.

TL: I got very good marks by rote learning but now I am regretting rote learning. Last time my students asked me a theorem which I wrote on the board well but I could not explain any more. It is difficult to teach rather than to learn, especially rote learning.

CL: Slowly you will get the idea. It takes time to understand the concept.

TL: Arbind, you must help me. The modern mathematics is really very difficult.

CL: Don’t worry my dear friend. I will help you.

TL: Now I must go. My class will start soon.

CL: Please, stay a while. I will prepare black tea.

TL: Sorry friend. I can not wait for tea. Bye.

CL: Bye.

My Reflections on the Five Episodes

The first episode portrays my practices of informal cooperative learning with my friends at home. I now realize that we did not have the formal set up of cooperative learning in the school classroom. We had informal group discussion and problem solving in the classroom in absence of the teacher and it was in good practice at home. There was more cooperation with little competition in the group. We used to share our ideas while solving a mathematics problem at leisure time in school or at home or elsewhere.

Episode two depicts my style of practicing mathematics in-group that was a kind of informal cooperative/collaborative learning. We used to practice and revise the chapters dividing certain responsibility among friends and teach each other. The day-to-day practice in-group developed our clear understanding of mathematics through interactions and group work.

Episode three and four are about how I was able to learn mathematics in my Master' Degree although I did not attend the class regularly. Exam was nearly coming and I was not well prepared. Then I was successful to form a cooperative team of four/five friends from the same level and practiced mathematics everyday for two months. That practice in group enabled me to do well in the final examination. The group work became good example for others too. The learning of mathematics in group/collaborative work was really beneficial to me as I could learn every concept clearly and meaningfully.

Episode five depicts the benefits of being a cooperative learner in professional development. The story of two classmates one with traditional rote learning habit and another with cooperative learning habit shows that cooperative learner can solve his/her problems confidently. But traditional rote learner can learn facts but cannot analyze the things contextually and falls behind in career development. So, cooperative learning not only made me confident in mathematics but it helped me to think humanistic way and interested to solve interdisciplinary problems among friends. It also shaped my personal character to live together with people cooperating each other in day-to-day problems.

In the same way, cooperative learning became a way of knowing mathematics for me. It was the way of solving mathematical problems. The cooperative group was formed around me from the beginning of my school days till the last day of my Masters degree. So it has become a major source of inspiration in the learning of mathematics, teaching mathematics and now research in mathematics education. It helped me to –write numerals at the beginning of schooling, solve simple mathematical operations, discuss difficult problems in group, build close tie with colleagues, create a learning group, develop social and cultural understanding, boost my morale up, think positively about mathematics and be a student of mathematics for ever.

In my understanding every mathematical concepts and ideas can be learnt and well understood through cooperative learning. Arithmetic, geometry, algebra, sets, probability, trigonometry, ….in school mathematics can be well grasped by cooperative approach. Similarly, in higher mathematics: analysis, algebra and higher geometry are the prime area in which cooperative learning becomes fruitful to understand the abstract nature of mathematics. In my experience statistics,

probability, calculus, operation research, history and philosophy of mathematics could be the more relevant areas for group work and discussion. But in fact to me all mathematical concepts from school to university level can be well understood through cooperative learning provided that the group members are adaptive and cooperative to each other.

Now I would like to discuss some theoretical referents of cooperative learning.

Theoretical Referents of Cooperative Learning

In my opinion, cooperation considered of working together to accomplish our shared goals. The shared goals were to solve problems, complete our assignments and prepare for the examinations (Johnson & Johnson, 1989). Within cooperative activities we individuals seek outcomes that were beneficial to us and beneficial to all other group members.

It seems to me that cooperative learning is the instructional use of small groups so that students work together to maximize their own and each other's learning (Johnson & Johnson, 1993). The idea seems simple. Johnson and Johnson (1989) state that class members are organized into small groups after receiving instruction from the teacher to work through the assignment until all group members successfully understand and complete it. To me, cooperative efforts result in participants striving for mutual benefit so that all group members gain from each other's efforts with the principle that “Your success benefits me and my success benefits you” (Deutsch, 1962; Johnson & Johnson, 1989). In my opinion, cooperative learning recognizes that all group members share a common fate and it is “We all sink or swim together here”,

knowing that one's performance is mutually caused by oneself and one's colleagues as" We can not do it without you", and feeling proud and jointly celebrating when a group member is recognized for achievement. I believe that in cooperative learning situations there is a positive interdependence among students' goal attainments; students perceive that they can reach their learning goals if and only if the other students in the learning group also reach their goals (Deutsch, 1962; Johnson & Johnson, 1989).

In my episodic narrations from one to five, the main objective of the group work was to achieve our common goal of understanding mathematics, completing assignments and passing our final exams. These goals brought us together in the form of a cooperative learning circle from the very beginning of my school life through the university level. It was also ourselves need to work together to succeed in our ventures of learning mathematics and other subjects as there was no other seniors to help us at the time. Our necessity brought us together in the form of a cooperative learning circle.

It is agreed that students' learning goals may be structured to promote *cooperative, competitive, or individualistic* efforts. I feel that in contrast to cooperative situations, competitive situations are ones in which students work against each other to achieve a goal that only one or a few can attain. So, it seems that in competition there is a negative interdependence among goal achievements. In my understanding, in competitive efforts students perceive that they can obtain their goals if and only if the other students in the class fail to obtain their goals (Deutsch, 1962; Johnson & Johnson, 1989). Competition, it seems to me, thrives on norm-referenced evaluation of achievement. The result can be that students either work hard to do better than their classmates, or they take it easy because they do not believe they have

a chance to win. On other hand, students also work alone in individualistic learning situations to accomplish goals unrelated to those of their classmates when they are evaluated on a criterion-referenced basis. In such a situation, I feel students' goal achievements are independent; students perceive that the achievement of their learning goals is unrelated to what other students do (Deutsch, 1962, Johnson & Johnson, 1989). Ultimately, in my point of view, the result is to focus on self-interest and personal success while ignoring as irrelevant the successes and failures of others. So, this leads to extreme personal perspectives of learning mathematics that does not value social interaction and sharing of ideas.

However, simply placing students in groups and telling them to work together does not necessarily result in cooperation. I think that not all groups are naturally cooperative: sitting in groups, for example, can result in competition at close quarters or individualistic effort with talking. So, the essential components of cooperation should be *positive interdependence, face-to-face promotive interaction, individual and group accountability, interpersonal and small group skills, and group processing* (Johnson, Johnson, & Holubec, 1993). It shows, to me, that systematically structuring those basic elements into group learning situations helps ensure cooperative efforts and enables the disciplined implementation of cooperative learning for long-term success.

Basic Elements of Cooperative Learning

Cooperative learning has some basic elements that form group learning as a cooperative learning. The basic elements of cooperative learning are: positive inter dependence, promotive interaction, individual and group accountability, interpersonal and small group skills, healthy social and psychological development, and group processing.

Positive Interdependence

For me and my group members and me the first and most important element in a structuring cooperative learning was *positive interdependence*. Positive interdependence was successfully structured when the group members perceived that they were linked with each other in a way that one cannot succeed unless everyone succeeds. Group goals and tasks, therefore, were designed and communicated to members in such ways that made them believe they would sink or swim together (Johnson & Johnson, 1989). In the words of Johnson and Johnson (1989), when positive interdependence was solidly structured, it highlighted that (a) each group member's efforts was required and indispensable for group success and (b) each group member had a unique contribution to make to the joint effort because of his or her resources and/or role and task responsibilities. I realized that in doing so we created a commitment to the success of group members as well as one's own and it was the heart of our cooperative learning. If there were no positive interdependence, there would be no cooperation.

Promotive Interaction

The second basic element of cooperative learning, in my experience, was *promotive interaction*, preferably face-to-face. Johnson and Johnson (1989) state that students need to do real work together in which they promote each other's success by sharing resources and helping, supporting, encouraging, and applauding each other's efforts to achieve. Johnson and Johnson (1989) further claim that there are important cognitive activities and interpersonal dynamics that can only occur when students promote each other's learning. I think that working together to achieve a common goal produces higher achievement and greater productivity than does working alone. This is confirmed by much research that it stands as one of the strongest principles of social and organizational psychology. Reputedly, Cooperative Learning, furthermore, resulted in more higher-level reasoning, more frequent generation of new ideas and solutions (i.e., process gain), and greater transfer of what is learned within one situation to another (i.e., group to individual transfer) than did competitive or individualistic learning. To me, the more conceptual the task, the more problem solving required, the more desirable higher-level reasoning and critical thinking, the more creativity required, and the greater the application required of what is being learned to the real world, the greater the superiority of cooperative over competitive and individualistic efforts.

In my understanding, promotive interaction includes orally explaining how to solve problems, teaching one's knowledge to others, checking for understanding, discussing concepts being learned, and connecting present with past learning. I think that each of these activities can be structured into group task directions and procedures in our cooperative learning circle (see Episodes One through Five). We did so in our group shared by helping ensure that the cooperative learning group was

both an academic support system and a personal support. It was through promoting each other's learning face-to-face that my colleagues and I became personally committed to each other as well as to our mutual goals throughout Episodes One to Five.

Differences among individuals in personality, sex, attitudes, background, social class, reasoning strategies, cognitive perspectives, information, ability levels, and skills have been found to promote achievement and productivity (Johnson & Johnson, 1989). I could not form heterogeneous cooperative learning circle in terms of sex. The reason is that our society did not permit male and female students to form a cooperative learning circle. The socio-cultural aspect of our society affected the formation of such a learning circle.

Individual and Group Accountability

The third basic element of our cooperative learning was *individual and group accountability.* I found two levels of accountability structured into our cooperative lessons. The group had to be accountable for achieving its goals and each member had to be accountable for contributing his or her share of the work as we did in the second last episode. Our individual accountability existed but there was no mechanism to assess it formally. So the performance of each individual was assessed informally based on how much other members benefited from him. We tried to share our ideas openly in order to ascertain who needed more assistance, support, and encouragement in learning. The purpose of cooperative learning groups was to make each member a stronger individual in his or her own right (Johnson and Johnson, 1989). We learned

together so that we subsequently could gain greater individual competency and succeed in the final examination.

Much of the research on interpersonal relationship has been conducted in the West on relationships between 'white' and 'minority' students and between 'handicapped' and 'nonhandicapped' students (Johnson & Johnson, 1989). There have been over forty experimental studies comparing some combination of cooperative, competitive, and individualistic experiences on cross-ethnic relationships. More than forty similar studies on mainstreaming of handicapped students have been conducted (Johnson & Johnson, 1989a). The results are consistent. Working cooperatively appears to create far more positive relationships among diverse and heterogeneous students than does learning competitively or individualistically (Johnson & Johnson, 1989).

Once the relationship is established, the next question becomes "why?" I agree that the social judgments individuals make about each other can increase or decrease the liking they feel towards each other. Such social judgments are the result of either a process of acceptance or a process of rejection (Johnson & Johnson, 1989). The process of acceptance is based on the individuals promoting mutual goal accomplishment as a result of their perceived positive interdependence. The promotive interaction for me tends to result in frequent, accurate, and open communication; accurate understanding of each other's perspective; inducibility; differentiated, dynamic, and realistic views of each other; high self-esteem; success and productivity; and expectations for positive and productive future interaction.

Interpersonal and Small Group Skills

The fourth basic element of our cooperative learning was the required *interpersonal and small group skills*. Cooperative learning is inherently more complex than competitive or individualistic learning because students have to engage simultaneously in task-work (learning academic subject matter) and teamwork (functioning effectively as a group) (Johnson & Johnson, 1989).

I think Johnson and Johnson (1989) are right to say, "Social skills for effective cooperative work do not magically appear when cooperative lessons are employed. Instead, social skills must be taught to students just as purposefully and precisely as academic skills." But in my days of schooling, teaching of mathematics never incorporated these social skills. Learning of mathematics in the classroom was more individualistic and nobody cared about others except in my cooperative learning circle. So, there was always a higher rate of failure in mathematics in comparison to other subjects.

In my opinion, leadership, decision-making, trust-building, communication, and conflict-management skills empower students to manage both teamwork and task-work successfully. Since cooperation and conflict are inherently related (Johnson & Johnson, 1995), the procedures and skills for managing conflicts constructively are especially important for the long-term success of learning groups (Johnson, 1991; 1993, Johnson & Johnson, 1994). In my understanding these elements were rare in my mathematics classroom although the class teacher or headmaster assigned some non-academic tasks in groups, such as preparation for national celebrations, sport and some co-curricular activities.

Healthy Social and Psychological Development

For me, when individuals work together to complete assignments, they interact (mastering social skills and competencies), they promote each other's success (gaining self-worth), and they form personal as well as professional relationships thereby creating the basis for healthy social development. I think that individuals' psychological adjustment and health tend to increase when schools are dominated by cooperative efforts. I think that the more individuals work cooperatively with others, the more they see themselves as worthwhile and as having value, the greater their productivity, the greater their acceptance and support of others, and the more autonomous and independent they tend to be. It seems to me that a positive self-identity is developed basically within supportive, caring, cooperative relationships while a negative self-identity is developed within competitive, rejecting, or uncaring relationships. So I think that children who are isolated usually develop the most self-rejecting identities.

It is generally accepted that cooperative experiences are not a luxury. They are a necessity for the healthy social and psychological development of individuals who can function independently. I think that healthy social and psychological development of individuals is the fifth important element of cooperative learning.

Much to our bad luck, there was no formal effort from the school to create cooperative groups in the classroom. We were not involved in cooperative learning of mathematics except for cleaning the classroom, bringing water for the school garden and celebrating some national festivals. It might be that our school system was not aware of cooperative learning as a powerful method of learning in groups. The same was the case in university study. There was no cooperative environment in the day to day classroom discussion. Teachers used to come, give lectures without enough

explanation and discussion and vanish from the class. It did not make much difference to me as I was a tourist student at the time but I did realize that the students were so paralyzed that they were not ready to share ideas, resources and knowledge. I think that my colleagues in university were so selfish due to the impact of the individualistic and competitive approach of learning. So, they did not accept my proposal to form a cooperative learning circle.

I could hardly find three people who agreed to join for cooperative learning. Anyway, I was successful in my mission of learning mathematics through cooperative learning though it was informal group learning, but we were fully committed to sharing ideas, opinions, resources and knowledge for our own benefit which was to understand mathematics to pass the examinations.

Group Processing

The sixth basic element of our cooperative learning was *group processing*. Group processing exists when group members discuss how well they are achieving their goals and maintaining effective working relationships (Johnson & Johnson, 1989). "Groups need to describe what member actions are helpful and unhelpful and make decisions about what behaviors to continue or change. Continuous improvement of the processes of learning results from the careful analysis of how members are working together and determining how group effectiveness can be enhanced" (Johnson & Johnson, 1989).

I think, at first, caring and committed friendships come from a sense of mutual accomplishment, mutual pride in joint work, and the bonding that results from joint efforts. The more students care about each other, on the one hand, the harder they will work to achieve mutual learning goals. Second, joint efforts to achieve mutual goals

can promote higher self-esteem, self-efficacy, personal control, and confidence in their competencies. So far as I have understood, the healthier psychologically individuals are, on the other hand, the better able they are to work with others to achieve mutual goals. Third, psychological health is built on the internalization of the caring and respect received from loved-ones. Friendships are developmental advantages that promote self-esteem, self-efficacy, and general psychological adjustment. The healthier people are psychologically (i.e., free of psychological pathology such as depression, paranoia, anxiety, fear of failure, repressed anger, hopelessness, and meaninglessness), on the other hand, the more caring and committed their relationships. To me, each outcome can induce the others; they are likely to be found together. So, I think, they are a package with each outcome a door into all three. And together they induce positive interdependence and promotive interaction.

Summary

In this way the first and most important element in structuring our cooperative learning was positive interdependence. The second basic element of cooperative learning was promotive interaction, preferably face-to-face. The third basic element of in our cooperative learning was individual and group accountability. The fourth basic element of our cooperative learning was the required interpersonal and small group skills. I think healthy social and psychological development of individuals was the fifth important element of cooperative learning. The sixth basic element of our cooperative learning was group processing. We were weaker in these aspects at the beginning at school level but these characteristics were dominant in the university level. I did not find any such formal effort from schools and university campuses to

encourage cooperative learning but I feel that I could practice cooperative learning of mathematics forming informal cooperative groups from school level to the university level.

Such cooperative learning in group not only helped me to understand mathematics, but it helped me to adjust myself in the group, develop a positive attitude towards mathematics learning, learning as concept building and social interaction in the group and, lastly, it helped me to develop my career in the field of mathematics.

Types of Cooperative Learning

Cooperative learning is the instructional use of small groups so that students work together to maximize their own and each other's learning (Johnson, Johnson, & Holubec, 1993). I think that within cooperative learning groups, students discuss the material to be learned with each other, help and assist each other to understand it, and encourage each other to work hard. Cooperative learning groups may be used to teach specific content (formal cooperative learning groups), to ensure active cognitive processing of information during a lecture or demonstration (informal cooperative learning groups), and to provide long-term support and assistance for academic progress (cooperative base groups) (Johnson, Johnson, & Holubec, 1993).

Formal cooperative learning. It is students working together, for one class period to several weeks, to achieve shared learning goals and complete jointly specific tasks and assignments (such as decision making or problem solving, completing a curriculum unit, writing a report, conducting a survey or experiment, or reading a chapter or reference book, learning vocabulary, or answering questions at the end of

the chapter) (Johnson, Johnson, & Holubec, 1993). Many course requirements or assignments may be reformulated to be cooperative. I think that in formal cooperative learning groups teachers should:

1. Specify the objectives for the lesson. In every lesson there should be an academic objective specifying the concepts and strategies to be learned and a social skills objective specifying the interpersonal or small group skill to be used and mastered during the lesson.

2. Make a number of pre-instructional decisions. A teacher has to decide on the size of groups, the method of assigning students to groups, the roles students will be assigned, the materials needed to conduct the lesson, and the way the room will be arranged.

3. Explain the task and the positive interdependence. A teacher clearly defines the assignment, teaches the required concepts and strategies, specifies the positive interdependence and individual accountability, gives the criteria for success, and explains the expected social skills to be engaged in.

4. Monitor students' learning and intervene within the groups to provide task assistance or to increase students' interpersonal and group skills. A teacher systematically observes and collects data on each group as it works. When it is needed, the teacher intervenes to assist students in completing the task accurately and in working together effectively.

5. Assess students' learning and helping students process how well their groups functioned. Students' learning is carefully assessed and their performances are evaluated. Members of the learning groups then process how effectively they have been working together.

I have mentioned these strategies for teachers in formal cooperative learning classrooms so that they will help them to manage a cooperative learning classroom. It is not that I had a cooperative classroom when I studied mathematics in school level to university, but I think that these should be the essential strategies in teaching and learning of mathematics from a constructivist point of view.

Informal cooperative learning. This consists of having students work together to achieve a joint learning goal in temporary, ad-hoc groups that last from a few minutes to one class period (Johnson, Johnson, & Holubec, 1992; Johnson, Johnson, & Smith, 1991) or few days. During a lecture, demonstration, or film, informal cooperative learning can be used to (a) focus student attention on the material to be learned, (b) set a mood conducive to learning, (c) help set expectations as to what will be covered in a class session, (d) ensure that students cognitively process the material being taught, and (e) provide closure to an instructional session.

In my opinion during direct teaching the instructional challenge for the teacher is to ensure that students do the intellectual work of organizing material, explaining it, summarizing it, and integrating it into existing conceptual structures. Informal cooperative learning groups are often organized so that students engaged in three-to-five minute focused discussions before and after a lecture and two-to-three minute turn-to-your-partner discussions interspersed throughout a lecture. I think students form an informal learning group to share ideas and opinions in the process of learning. The informal group can work within or outside the school. The group members share the responsibility and enhance their learning of mathematics.

Cooperative base Groups. Cooperative base groups are long-term, heterogeneous cooperative learning groups with stable membership (Johnson, Johnson, & Holubec, 1992; Johnson, Johnson, & Smith, 1991). The purposes of the

base group are to give the support, help, encouragement, and assistance each member needs to make academic progress (attend class, complete all assignments, learn) and develop cognitively and socially in healthy ways. Base groups meet daily or thrice a week (or whenever the class meets) and help each other to master the problem solving and concept learning in mathematics.

I think they are relatively permanent (lasting from one to several years) and provide the long-term caring peer relationships necessary to influence members consistently to work hard in school. They formally meet to discuss the academic progress of each member, provide help and assistance to each other, and verify that each member is completing assignments and progressing satisfactorily through the academic program. Base groups may also be responsible for letting absent group members know what went on in class when they miss a session. Informally, members interact every day within and between classes, discussing assignments, and helping each other with homework. The use of base groups tends to improve attendance, personalize the work required and the school experience, and improve the quality and quantity of learning. The larger the class or school and the more complex and difficult the subject matter, the more important it is to have base groups. Base groups are also helpful in structuring homerooms and when a teacher meets with a number of advises.

I think that my cooperative learning circle was not a formal cooperative learning group as it had not been formed formally in the classroom by the subject teacher. It seemed closer to an informal cooperative learning group on the basis of its functioning and formation. It resembled a cooperative base group as it was relatively permanent for a year or more based on the level and complexity. My cooperative learning circles up to high school level were somewhat of a cooperative base group but it was more informal as in university level.

It seems to me that the current research indicates that cooperative learning promotes greater efforts to achieve, more positive relationships, and greater psychological health than do competitive and individualistic learning. These outcomes indicate that when cooperative learning is used the majority of the school day, diversity among students can be a potential source of creativity and productivity (Johnson & Johnson, 1997).

Rationale of Cooperative Learning

From a pedagogical standpoint, Silvia et al. (1985) root the rationale for organizing instruction in cooperative settings in the work of John Dewey who emphasized social aspects of learning and the role of the school in educating students' cooperative democratic living. I think that this idea that all learning takes place in a social context is echoed in the work of later educational psychologists such as Piaget and Vygotsky. The old adage that the whole is greater than the sum of its parts comes to mind when I think about cooperative learning. To me, each student brings to the discussion some information, which he/she alone possesses and adds it to the collective knowledge base, used to solve a problem. I think that combined, the bits and pieces contributed are likely to be better than any one student would have arrived of as a solution.

Reynolds et al. (1995) give evidence from research that students in class using cooperative learning can develop a more positive attitude towards themselves and towards mathematics. The feeling of helplessness and past failures can be ameliorated by the liberating experience of being allowed to consult with peers while struggling with a mathematics problem. In an analogous situation, perhaps a problem with a personal relationship, it is quite natural to discuss the problem with friends, seek the

advice of experienced person or a counseling professional or reflect upon the accumulated input and make a decision. Yet in the tradition mathematics classroom, students are expected solve problems alone rather than 'cheat' and ask a colleague for help.

Perhaps the best argument I can make for cooperative learning methods in my class is that teaching has become more enjoyable for me. I have the opportunity to observe the students engaged in doing or at least tackling mathematical problems. I can listen to their questions, to correct misconceptions, to follow discussions wherever they may lead. Teaching in a cooperative is like an independent travel.

So, in my understanding, some of the rationales behind cooperating learning are –

1. To liberate students from traditional set of learning environment.
2. To facilitate effective and meaningful learning.
3. To encourage peer or group work for the development of social attitude.
4. To make teaching more enjoyable rather than monotonous.
5. To develop positive attitude towards mathematics and themselves.

Bernero (2000) states that in many elementary classrooms maths tends to be individualized work with repetitive paper-pencil assignments. He conducted research as an attempt to generate more interest in math, reduce math anxiety, and make math more enjoyable for students (Bernero, 2000). He further states that through the use of cooperative learning the students practiced and developed social skills needed to successfully accomplish given tasks and projects.

I think that cooperative learning encourages group interaction with assigned roles, with each member sharing responsibility for the group and the work produced. Bernero (2000) says that cooperative learning makes students an active and creative

role player in the group by sharing responsibility. In my learning with friends, it was almost an informal group cooperative learning. At the time, the school did not have such a method of forming cooperative groups in the classroom teaching and learning. My practice of learning in a cooperative group with sharing some responsibility among friends was natural and I think it was due to social need, need for help, need for affection in a group and work together to share resources (at least kerosene oil) among the group members. This led to convince the guardians and parents for the group learning/ cooperative learning to maintain the success rate in the class.

Researches in Cooperative Learning

When I read the paper "Motivating Students in Math Using Cooperative Learning" a study report by Bernero (2000), I came to know that many people have mathematics anxiety which is a fear of math or an intense, negative emotional reaction to the subject. Researches have shown that mathematics anxiety in adult has been common to some degree and it has been found to start from the elementary level (Kennedy & Tipps, 1994). Many people have given up on math because they learned to fear it when they were young (Bernero, 2000). This fear or loathing in math "seems to make people underpowered to make decisions themselves. Instead they will defer to someone they think is smart", explains Marlin Burns (as cited by Rasmussen, 1999). Once adopted these feelings of math anxiety are hard to lose, even in adulthood (Rasmussen, 1999).

The case was equally applicable to my colleagues. Some of them had higher level of math anxiety when they were in grade ten. Prakash and Bishnu in episode two were below average in my class. They were very poor in mathematics at the time when

they joined my school from other schools. They were suffered highly from math anxiety. I had been cautioned by my parents and seniors when I involved them in my cooperative circle. But later they did very well in mathematics when they started working in my cooperative learning circle. They accepted the challenges of mathematics and kept on improving. Whereas for, Bharat, from the time he left my cooperative group, his average achievement in mathematics decreased and he lost his position in the class.

In the problem context, (Bernero, 2000) states, “Besides students who may be feeling math anxiety, there are students that may find math to be just plain boring, given customary paper-and-pencil repetitive math problems. Adults who had negative feelings regarding math report certain teacher practices and expectations that also contributed to their anxieties (Kennedy & Tipps, 1994). Among these are –

Lack of variety in teaching and learning processes

Emphasis on memorization

Emphasis on speed

Emphasis on doing one’s own work

Authoritarian teaching

Kennedy and Tipps (1994) further discuss that in many elementary math classes more than seventy percent of time is spent in independent practice, mostly in paper-and-pencil tasks. This means that children often have had little instruction in mathematical concepts and processes they practice. “Do your own work” has been a dictum in many elementary classrooms (Kennedy & Tipps, 1994). So, the average achievement in mathematics was lower in comparison to other subjects.

The focus of their study was “to see to what extent the use of cooperative learning will generate more subject interest, reduce math anxiety, and make math more

enjoyable for students. The study intended to ascertain whether adding cooperative learning to the mathematics curriculum as an instructional strategy would alleviate the traditional student problems" (Bernero, 2000). "Teacher who encourage group work, know about the social and academic benefits for children who together, share ideas, and explain concepts to help another understand mathematics" (Kennedy & Tipps, 1994. p.15).

I think direct teaching is the mode of learning experienced by many people. Learning in this manner tends to be very passive and memory-based, making low cognitive demands on learners. Robert Gagne has challenged this type of direct instruction as ineffective. He believes the teacher needs to actively engage the students in learning (Kennedy & Tipps, 1994). Conclusions from research on effective learning and teaching are consistent with this thinking.

The study by Bernero Jacqueline (2000) systematically investigated and reported the benefits of cooperative learning being used as an important tool and the extent to what cooperative learning apparently modifies existing student perceptions towards math possibly school in general.

As I found in the report, the project result was that from teachers' observation of students' team interactions, social acceptance and working as a team gradually improved. From the report of the project, I found, the teachers noticed improvement in the self confidence of the slow learners and a more positive attitude with fewer problems from the *discipline problem students*. It seemed that, academically, students improved in classwork and text scores. Statistics showed that there was dramatic increase in the number of students able to keep up with their math grades throughout the second and third quarters from the previous school years. According to the report the class in general showed they understood and could apply concepts learned to solve

problems. In comparing students' individual work with group work, it was found that students who already did well in math continued to do so both individually and with a group. In my understanding, those who struggled with math continued to struggle and became frustrated with the individual work, but improved academically and in self-confidence (thus leading to social improvement) when it came to group work, as the report has stated.

So, I think with cooperative learning, it was observed that the social environment of the classroom became more positive. To me, as the classroom engaged in more cooperative activities, a unity or a caring atmosphere seemed to emerge for the class that carried throughout the school day, not only during math. This in turn, I think, made the day more enjoyable for the teacher and students. According to the report discipline problems were fewer, and mainstreamed and slower learners were accepted and felt to be part of the group. I feel that cooperative learning did much more to foster a caring teamlike atmosphere. It definitely built one's self esteem and encouraged even shy students to assert themselves (Bernero, 2000).

Bernero (2000) states that the fact that 80% of students kept their grades at an average level or above can be attributed to students being able to share and hear each other's way of thinking through a problem and coming to a solution. So, I think, when one is able to use what they are learning by listening, speaking, doing and teaching (to their peers), the concept or idea, becomes more thoroughly understood and engrained in one's mind whether it is math or any other subject matter (Bernero,2000). Drastic improvement in the math achievement of Prakash and Bishnu in episode two resembles the result in this study.

The study report by Bernero (2000) further states that cooperative learning activities enabled many of the *discipline problem students* to be actively involved in

learning, take responsibility for their job, in many cases use hands on manipulative and allowed room for discussion. According to the report, the result showed improved relations between the *discipline problem students* and other team members. I, think, for mainstreamed and slower students, cooperative learning seemed to help bring them up to speed, possibly because it allowed discussion among group members and willingness on the team members' parts to help and explain both concepts and processes. The teacher noticed a definite improvement in the self confidence of those slow learners and a more positive attitude with fewer problems from the *discipline problem students* (Bernero, 2000). There was a change in the attitude of Prakash in the school after he joined in my cooperative learning circle. Even my parents had warned me not to be keeping him in my circle but I replied to my parents that their involvement in my group does not change me in their way but they will be changed in my way. Later it happened that Prakash became a more social and disciplined student than other *discipline problem students* at the time.

The study report by Bernero (2000) does not speak of only the positive side of cooperative learning; it also has shown some negative aspects too. While most of the results of using cooperative learning in math were found to be positive, there were also some negative aspects. In the paper I found that from the teacher's standpoint, a main problem was how to keep control over the noise level. So, the class was always reminded before activities to keep voice with only one team member talking at a time. Some ways of handling this were to count to three, turn off lights or do quiet "follow me" activity to get students' attention. But when any of these did not work, as a last resort, it was "heads down!" Bernero (2000) says as the year progressed, the class did improve slightly and the teacher found it to have one team member to monitor the noise level and conversation topics.

According to Bernero (2000), a second challenging area was necessity to keep teams/pairs on task. I think this was not as a great problem as might be expected, but constant monitoring was needed by both teach and students to make sure teams were on track.

Another challenge, as Bernero (2000) states, was how to deal with students who did not get along socially or disagreed about who was to do what job. I came to know that when students called for teachers to settle a dispute, he/she always encouraged students to work it out amongst themselves. I also got the idea that only as a last resort did he/she intervene, even then responsibility was put back on the students, after they had expressed their view points, to come to a decision.

Bernero (2000) further stated that making sure everybody took responsibility for his or her job was constantly reinforced. I feel that this was somewhat of a problem at the beginning of the year. Those students who tended to be reversed and the slower learners were usually the ones who needed to be reminded that their job was an important part of completing the activity. I came to understand that as the year progressed, every one became more accustomed to cooperative learning; this did not prove to be continuing, significant problem anymore.

Bernero (2000) recommended the following for cooperative learning to be implemented:

Get input and personal feelings from students as well as an evaluation of students' progress.

Take into consideration the teacher's tolerance of noise, combined with reasonable expectations of students.

Designate a student to monitor noise level and group conversation topics.

Take into consideration students who don't ordinarily get along when forming cooperative groups.

The report at last concludes that it is important to have a balanced approach in presenting subject matter to students. It also has emphasized the traditional approach of teaching as saying there are many times when direct instruction is needed and is the best way to teach a concept or subject. So, I think it should be kept in mind that this project did not employ cooperative learning a hundred percent time. It seems that it was infused gradually and became an often used way of teaching as situations dictated. Finally Bernero (2000) concludes his report, that given the results of the project, cooperative learning benefits far overweigh the negatives.

I preferred to discuss "Motivating Students in Math Using Cooperative Learning", a study report by Bernero (2000), though it does not directly reflect my experiences but it has some essence of cooperative learning in a classroom setup. In my case, the cooperative learning was more informal and not controlled by the teacher. My aim here is to encourage the teachers and educators to implement cooperative learning as a technique of teaching and learning of mathematics to encourage the students in meaningful learning through social and group interactions.

Another study was conducted on the "Effectiveness of Variations in Collaborative Cooperative Learning in RDS Mathematics Classes" by Hardin and Fletcher (1994). In the abstract, the authors state alarming questions are being asked of the teaching methods in present use. They have raised the question: Are we maximizing the time on task in the classroom? They studied students (n=98) in a remedial mathematics course for one semester and students (n=56) from a developmental mathematics course in the second semester, at Tennessee Technological University. They divided the students into four different groups--traditional cooperative learning, ability aligned cooperative

learning, alphabetical cooperative learning, and a non-cooperative learning control group. The researchers pre-tested each of the groups for mathematics and post-tested with the same instrument at the end of the semester. In their findings, though results did not indicate statistically significant differences favoring the cooperative learning groups over the non-cooperative control group, the greatest gains were by the traditional cooperative groups. The other cooperative learning groups did not gain appreciably differently from the non-cooperative groups.

A study on "Cooperative Learning Methods: A Meta-Analysis" was conducted by Johnson, Stanne and Johnson (May, 2000). The authors have summarized in the abstract as saying cooperative learning is one of the most widespread and fruitful areas of theory, research, and practice in education. According to the authors reviews of the research, however, have focused either on the entire literature which includes research conducted in non-educational settings or have included only a partial set of studies that may or may not validly represent the whole literature. The authors further state that there has never been a comprehensive review of the research on the effectiveness in increasing achievement of the methods of cooperative learning used in schools. They argue that an extensive search found 164 studies investigating eight cooperative learning methods and the studies yielded 194 independent effect sizes representing academic achievement. According to the findings, all eight cooperative learning methods had a significant positive impact on student achievement. It had been found that the impact of cooperative learning was compared with competitive learning, Learning Together (LT) promoted the greatest effect, followed by Academic Controversy (AC), Student-Team-Achievement-Divisions (STAD), Teams-Games-Tournaments (TGT), Group Investigation (GI), Jigsaw, Teams-Assisted-Individualization (TAI), and finally Cooperative Integrated Reading and Composition

(CIRC). Their report states that when the impact of cooperative lessons was compared with individualistic learning, LT promotes the greatest effect, followed by AC, GI, TGT, TAI, STAD, Jigsaw, and CIRC. Finally the authors claim that the consistency of the results and the diversity of the cooperative learning methods provide strong validation for its effectiveness.

According to Johnson, Stanne and Johnson (May, 2000) knowing that cooperative learning can significantly increase student achievement (compared with competitive and individualistic learning) when properly implemented does not mean, however, that all operationalizations of cooperative learning will be effective or that all operationalizations will be equally effective. So, to me, without reviewing the research on the different cooperative learning methods, it is difficult to recommend specific cooperative learning procedures to educators. This meta-analysis, therefore, focuses on four issues:

(a) determining how much research has been conducted on cooperative learning methods, (b) determining how many different cooperative learning methods have been evaluated, (c) determining how effective each method evaluated is in maximizing student achievement, and (d) determining the characteristics of the more effective cooperative learning methods.

The first issue, according to Johnson, Stanne and Johnson, was to determine the amount of research that has been conducted on cooperative learning methods. All together the authors found one-hundred-sixty-four studies on specific cooperative learning methods. The studies have been conducted at all levels of schooling (46 percent were conducted in elementary schools, 20 percent were conducted in middle schools, 11 percent were conducted in high schools, and 24 percent were conducted in post-secondary and adult settings) and the majority lasted for considerable time (46

percent lasted for 30 sessions or more, 52 percent lasted for 2 to 29 sessions, and 2 percent of the studies lasted only for one session). They found that most of the studies used good to excellent methodology (45 percent randomly assigned participants to conditions, 25 percent randomly assigned groups to conditions, and only 30 percent did not randomly assign participants or groups to conditions). It was found that the research had been conducted in North America, Europe, the Middle East, Asia, and Africa and has involved minority as well as majority populations. Thus, there was considerable research on specific cooperative learning methods and the research had considerable validity and generalizability. The authors argue that as with the overall research, educators can have a great deal of confidence in the effectiveness of cooperative learning.

According to Johnson, Stanne and Johnson (2000) the second issue investigated was to determine how many different cooperative learning methods had been evaluated. Of all the numerous ways that cooperative learning was used, only eight methods had been subjected to empirical validation in a way that a relevant effect size could be computed. Of these methods, some had more empirical support than others. They further argue that the more research studies conducted on any method, the more valid and reliable the results can be expected to be. So far as they had found, there were 113 independent effects in the studies on Learning Together and Constructive Controversy, 66 independent effects in the studies on the cooperative learning methods developed at Johns Hopkins University, 12 independent effects in the studies on the Jigsaw Procedure, and 3 independent effects in the studies on the Group Investigation Method. To them, it was somewhat surprising that so few methods had been evaluated.

To the authors the third issue investigated was the effectiveness of the different cooperative learning methods researched. There was no reason to expect that all operationalizations of cooperation would be effective. While the largest effect sizes were found for the Learning Together, Constructive Controversy, Teams-Games-Tournaments, and Group Investigation Methods, all of the methods have substantial effect sizes and all of the methods have been found to produce significantly higher achievement than did competitive or individualistic learning.

I think that the diversity of the eight cooperative learning methods provided additional validation of the effectiveness of cooperative learning. The methods ranged from specific procedures (such as Jigsaw and CIRC) to conceptual frameworks educators used to build their own cooperative lessons (such as Learning Together and Group Investigation) to curriculum packages in which cooperative learning was a central part (such as TAI and STAD), to rather complex procedures that required some sophistication to use (such as Constructive Controversy). According to Johnson, Stanne and Johnson (2000) that all of these methods were effective in increasing achievement was a tribute to the power of cooperation.

According to Johnson, Stanne and Johnson (2000) the fourth issue investigated was the characteristic of the different cooperative learning methods. Among the researcher-developers of cooperative learning, there were those who believed that the best way to ensure implementation of cooperative learning was to devise very specific techniques that teachers could learn in a few minutes and apply immediately (direct approach) and those who believed that teachers had to learn a conceptual system and used it to adapt current lessons and activities into cooperative ones (conceptual approach). Previous research indicated that direct methods might be easier to learn and implement than were conceptual methods, but once implemented,

conceptual methods were more robust and were more frequently maintained over time and easier to adapt to changing conditions and circumstances (Antil, et al., 1998; Berman, 1980; Berman & McLaughlin, 1976; Fullan, 1981; Griffin & Barnes, 1984; Johnson, 1970, 1979; Johnson, Druckman, & Dansereau, 1994; Johnson & Johnson, 1994a, 1994b; Joyce & Showers, 1980, 1982; Smith & Keith, 1982).

Johnson, Stanne and Johnson (2000) state that there is very little research, however, on whether direct or conceptual methods differentially affect achievement and productivity. I think, the results of this meta-analysis indicate that the more conceptual the method of cooperative learning, the greater its impact on student achievement tends to be. It is agreed that this is an important addition to the literature on implementation and institutionalization of innovations.

Despite the amount and diversity of the research, several conclusions about the effectiveness of the cooperative learning methods may be made (Johnson, Stanne & Johnson, 2000). It seems, first, while future research is needed, conducting research to compare directly the effectiveness of different cooperative learning methods is not very helpful. I think that studies in which two or more methods of cooperative learning are directly compared are difficult to interpret, especially if they are conducted by a researcher-developer who has a vested interest in one of the methods. So, I think that it is virtually impossible to implement different methods at exactly the same strength. To me if one method is strongly implemented and another method is weakly implemented the resulting differences would be due to the strength of the implementation, not the differences between the methods (Johnson, Stanne & Johnson, 2000).

Second, the differences in effect sizes for the different cooperative learning methods should be interpreted cautiously (Johnson, Stanne & Johnson, 2000). I think

that the measures of academic achievement in various studies may not be equivalent. Lower effect sizes, for example, would be expected on standardized tests than on non-standardized tests. In my point of stand, methods of cooperative learning aimed at lower-level tasks may produce high effect sizes on simple recognition level tests than methods of cooperative learning aimed at higher-level reasoning and critical thinking. Thus, a lower effect size may be due to the type of measure of academic achievement or the match between the method and the dependent measure, not the overall effectiveness of the method.

Third, to me, more research is needed on the various methods. I think the more studies conducted on a method, the more accurate the effect size may be. Conclusions about methods that have only a few validating studies could be misleading (Johnson, Stanne & Johnson, 2000).

Fourth, most of the validating studies on methods of cooperative learning, to me, have been conducted by the researcher-developer who originated the method. I believe that this introduces potential bias into the results. Ancient Romans advised individuals to ask, "cui bono" (who benefits) and the researcher-developer often has interests at stake that may bias his or her results toward confirming the effectiveness of his or her program (Johnson, Stanne & Johnson, 2000).

Philosophical Foundation of Cooperative Learning

I think that cooperative learning has a strong philosophical foundation in constructivism. The constructivist theory, to me, takes the view that learning is constructed. According to constructivism, new knowledge is built using what students already know. That is, their prior knowledge influences what they construct. It seems to me that in the constructivist model, learning is active, not passive as in a traditional model. In the constructivist model, students confront their understanding in light of what they encounter. It seems that students apply understanding and note relevant elements in modifying knowledge. Jonassen (1994), states that collaborative learning environments support "collaborative construction of knowledge through social negotiation, not competition among learners for recognition."

In my point of view there are a number of implications for teachers in a constructivist approach with respect to cooperative learning. In this approach, first of all, the teacher is a guide, not the lead, as students construct their own knowledge. In addition, due to various backgrounds, not all students will understand everything in the same way. Hence the teacher, through cooperative learning, can have them engage in activities which will allow them to understand their own thought processes and those of their peers, just by giving them a chance to voice them in group settings.

Vygotsky also refers to the zone of proximal development. According to Vygotsky (1978), the zone of proximal development is the difference between what a student can do alone and what he/she can do with supportive collaboration or cooperative activities in group. It seems to me that according to Vygotsky, all learning must take place in cooperative settings as, cognitively, connections cannot be made without this collaboration. Actually to me in any classroom, cooperative learning

cannot take place all of the time. In addition, it seems unrealistic that the only cognitive learning that can take place is through collaboration.

In my understanding, adopting a structured, cooperative approach offers faculty members both the philosophical approach and the specific tools to transform their teaching. So, the philosophy to me is a constructivist theory of learning that places the responsibility for students' learning on the students themselves. Students receive support from their teachers and from their peers. Cooperative structures include a wide variety of activities suitable for different objectives. For example, a roundtable activity where student teams of 4-5 add ideas to a rotating paper as they say them aloud provides a structured brainstorming technique which can result in meaningful learning.

In this way, I think, cooperative learning offers a systematic, student-centered approach to instruction without putting anyone into a pedagogical strait jacket. It seems that lecturing and other approaches thus complement the cooperative principles. I was highly committed to cooperative learning which built up on a set of pedagogical values that I took up (Johnson, Johnson & Smith, 1991). When a classroom is characterized by ethnic, class, or religious diversity, a classroom climate shaped by cooperative learning is of particular value. Because cooperative learning methods enable all students to speak in class, share ideas, and challenge each other, the unique contributions of students are brought to the fore. When students from different countries, with distinct socio-economic backgrounds, sexual, and gender identities describe their experiences with families, schools, religious and societal institutions, the pool of ideas, concepts, and images out of which we draw our material for discussion with each other is varied and enriched. In turn, our learning is enhanced. In particular, because students learn in a classroom characterized by

diversity to view situations and problems from perspectives other than their own, they acquire a critical competency for cognitive and social development. In my thinking, of course, the pedagogical values described here are not exclusive to cooperative learning in discussion oriented classes.

Nakahara and Koyama (1998) have stated the five principles that are entitled the 'Constructive Approach':

Children acquire mathematical knowledge by mental constructions of their own (Piaget, 1966, 1970; von Glasserfield, 1981, 1987, 1988; Cobb, 1989, 1991; Steffe & Wood, 1990; Ernest, 1991).

Basically, children construct and acquire mathematical knowledge in the process of being conscious, operational, meditative, reflective and making agreement (Herscovics & Bergeron, 1988; Pirie & Kieren, 1989).

In the process in which children are constructing mathematical knowledge, operational activity and reflective thinking play major roles (Piaget, 1966, 1970; Skemp, 1971, 1987).

Children construct, criticize and refine mathematical knowledge through constructive interaction with their teachers or with other children and then agree that it is viable knowledge (Cobb, 1991; Kamii, 1985; Yackel et al., 1990).

While children are constructing mathematical knowledge, five modes of representation, i.e. realistic representation, manipulative representation, illustrative representation, linguistic representation and symbolic representation play important roles (Bruner, 1966; Lesh et al. 1983, 1987). These five modes of representation play a significant role in learning of mathematics and constructing knowledge. Level of construction is directly linked with how children represent it.

My beliefs on what education is and what the role of the learner is are most closely related to progressivism. Progressivism is a student-centered philosophy that focuses on the students' needs, and I feel this is essential to learning. Progressivism takes into account that the world is always changing and educational experiences must be flexible to accommodate that.

Progressive classrooms are democratic because the students and teachers work together to decide what and how to learn. I like this because it means that the teachers must get on a more personal level with the students to learn about their abilities, their interests and their needs. I think teachers can better determine what will be relevant and meaningful to their students and make the curriculum more individual for each of their students. Students will learn better if they are interested in what is being taught, it is within their abilities, they find meaning in it, and they are able to relate it to themselves and their lives that are all possible through cooperative learning.

I agree with the progressivist philosophy on experience learning. I am going to be a mathematics educator and I believe that the best way for students to learn math is through experiencing it and creating meanings out of it. Students need hands-on learning to see, understand, and actually do activities themselves. Through the experience I was able to find meaning in what they were learning and was able to relate it to their interests and their lives. Actually experiencing what is being taught leads to questions and more learning. I think, it encourages creativity and elaboration. Along with hands-on learning, I also believe in minds-on learning. I wanted to be involved in learning experiences that require students to think critically, make predictions and problem solve.

I think, I should appreciate the use of cooperative learning in the progressive classroom where communication is a catalyst for learning. It seems to me that

cooperative learning taught me to work together as a group, contribute responsibly and other important social skills. It is believed that students can learn from each other and teach each other. Students assist each other in working toward a common goal.

I think that the role of the teacher in the progressivist theory is that of a facilitator. I feel this is essential to the student's optimal experience in the classroom. Students are allowed more freedom in problem solving and achieving the learning objectives through group work. The teacher is there as their guide, answering questions and offering suggestions, but not controlling or lecturing.

So far as I have understood, students and teachers of a progressive classroom work together to set attainable goals that they want to reach through the cooperative learning experience. I believe the best way to evaluate students then, is if they have reached the goal, or how close they come, and how they went about reaching the goal. I think the evaluation process is then individualized for each student. Progressivist style evaluation avoids standardized tests and focuses more on skill achievement and understanding of material. I believe in using authentic assessments that make the process relevant and meaningful to the student.

In the progressive classroom and from the progressive teacher, students learn creativity, critical thinking and problem solving skills, and social skills. Students accomplish all of this through cooperative learning, experimentation, hands-on activities and guidance from a teacher who understands their individual needs, interests, and ability levels.

In relation to my style of learning mathematics in group, it was a constructivist way of learning mathematics through socio-cultural relations and positive interdependence among the members in the group. The episodic narrations from one to five depict my role and the role of my group members in the mutual sharing of

ideas, efforts and resources. Though we were not guided by teachers in the group, we were guided informally by principles of cooperative learning.

Limitations of Cooperative Learning

While most of the results of using cooperative learning in math were found to be positive, there were also some negative aspects. In the paper I found that from the teacher's standpoint, a main problem was how to keep control over the noise level. So, the class was always reminded before activities to keep voice with only one team member talking at a time. Bernero Jacqueline (2000) says as the year progressed, the class did improve slightly and the teacher found it to have one team member monitor the noise level and conversation topics. According to Bernero Jacqueline (2000), a second challenging area was necessary to keep teams/pairs on task. I think this was not a great problem as might be expected, but constant monitoring was needed by both teach and students to make sure teams were on track. Another challenge, as Bernero Jacqueline (2000) states, was how to deal with students who did not get along socially or disagreed about who was to do what job. I came to know that when students called for teachers to settle a dispute, he/she always encouraged students to work it out amongst themselves. I also got the idea that only as a last resort did he/she intervene, even then responsibility was put back on the students, after they had expressed their view points, to come to a decision.

The report at last concludes that it is important to have a balanced approach in presenting subject matter to students. It also has emphasized the traditional approach of teaching as saying there are many times when direct instruction is needed and is the best way to teach a concept or subject. So, I thing, it should be kept in mind that this

project did not employ hundred percent the time. It seems that it was infused gradually and became an often-used way of teaching as situations dictated. Finally Bernero Jacqueline (2000) concludes his report that given the results of the project, cooperative learning benefits far overweigh the negatives.

In my episodic journey of cooperative learning, the major limitations were that it was initiated informally and so it did not have some key elements such as individual and group accountability. The groups were not well structured and the cooperative learning process was not formally guided by school or teachers. The cooperative process was purely social and cultural impact rather than intervention of the school system. There was serious lacking of group responsibility that is the members were not bound by any formal responsibilities that sometimes hindered in the process of sharing ideas and learning mathematics effectively.

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Epilogue

My episodic reflections and the subsequent theory on cooperative leaning shows that cooperative learning itself is not an end, but it a means to enhance learning of mathematics with group work, sharing of ideas among the group members, building social and cultural tie among the members of the group formally in the classroom or informally at home or outside. It is a way of teaching and learning mathematics with group solidarity, mutual understanding of diversity, and forming a cohesive group as a dynamic learning group. I employed cooperative learning in the classroom setup in the school and university negligibly but it remained a dominant part of learning mathematics from school level to university as informal cooperative learning.

The scope of understanding mathematics with cooperative learning became wider at the higher level as the problems were more challenging and I was more independent of the campus. In school days, cooperative learning helped me to do classwork, homework, and other assigned jobs but in the university level, it became indispensable as I could not attend regular classes. So there was greater advancement in the nature of cooperation in my university study.

I found cooperative learning a very useful and effective tool for learning mathematics. I could develop self confidence of not only myself, but also it was helpful to develop confidence in my colleagues who were going to leave the exams though they had attended the class regularly. It always became my ray of hope to see the horizon. Cooperative learning became my powerful lens to see the world of mathematics through the window of my mini feel.

CHAPTER 4

A PORTRAYAL OF PEDAGOGICAL METAMORPHOSIS

What is Metamorphosis?

> After swimming for some time the tornaria larva sinks down the bottom. Its transparency is lost and the ciliated bands are disintegrated. Eyes are also lost. The body elongates and is distinguished into the proboscis, collar and trunk and simultaneously the notochord, gill-slits and coelomic sacs are also formed. Thus the larva gradually changes into the adult. (Jordan & Verma, 1993, p. 1021)

Pedagogical metamorphosis seems a good topic for my research but it is extremely painstaking to reproduce the pedagogical practices that I had and I have in my practice in text and narratives. I have tried to link my pedagogical perceptions and practices from the early days until now, but I found myself in a dilemma. What is pedagogy? How does it enter into the process of metamorphosis? What was my pedagogy and what is my pedagogy now? How to represent my pedagogic practices, beliefs and biases in the narrative text and textual?

The dictionary meaning of metamorphosis is a change of appearance; change from one form into another one. We can observe metamorphosis in geology, zoology and biology. It seems to me that metamorphosis in geology is a change of mineral composition, structure and texture inside rocks, due to higher pressure, temperature and chemical factors. Metamorphosis is creating new minerals or changing existing ones. I think that zoological and biological metamorphosis is a passage from one

evolutional step to another one with important changes in appearance (for example the transformation of a tadpole into a frog). To me, metamorphosis is a change of nothing into something, from something simple into something complicated, perhaps a fool into a sage.

It seems to me that beliefs and practices also change with experience, study and new knowledge. A child learns social behaviors and becomes a good citizen in later days. A student learns a lot from school level to university and becomes a good professional or good thinker. A teacher can change his/her pedagogical practices with time and context after long experience, study and training. I think that such changes in the practices of teaching and learning from behaviorist to constructivist or traditionalist to modernist and postmodernist constitute a pedagogical metamorphosis. Pedagogical metamorphosis is parallel to philosophical metamorphosis, but I have dealt both with the name “pedagogical metamorphosis”.

Pedagogical Practices

I have experienced myself that my teaching and learning practices have changed a lot with the passage of time during the past eighteen years. I was teaching Bishal without any idea of the teaching and learning process. I did not have knowledge of how children learn and how their learning can be enhanced. I was simply a transmitter of knowledge from me to Bishal, by hook or by crook. Perhaps, trial and error was my technique of teaching him mathematics.

When I finished my B. Ed. Degree in mathematics education, I had some idea about methods of teaching mathematics. I had learnt about Bloom’s taxonomy of

behavioral objectives during the learning process. But I was guided by a behaviorist approach to the teaching and learning of mathematics. After my M.Ed. Degree in mathematics, I was impressed by Piaget's theory of learning. Developmental psychology became my guiding principle of teaching and learning of mathematics. Gagne, Ausubel, Bruner and Bandura's learning theories had been inscribed into my pedagogical practices. Piaget's theory was more dominant during my teaching at secondary and lower secondary levels.

Later on, during my course of teaching mathematics at Kathmandu University School of Education, more changes came in to my pedagogical perception and practices. My teaching of mathematics to undergraduate level at TU some years ago and now at KU has been characterized by a wide ranging paradigmatic shift, from a more traditionalist and behaviorist approach to a modern and constructivist approach. I feel that my thinking and views the knowledge-making process have a shift from a positivist approach to post-positivist and then to a postmodernist view with a belief in subjective knowledge and multiple genres of constructing knowledge and doing research. In this way I can claim that there has been paradigmatic metamorphosis in my viewing of the world, knowledge construction, and research practice. Certainly this is a pedagogic metamorphosis in perception, belief, and intellect and practice as well.

My school-mathematics teacher resigned from his post. I was appointed to his position and my career to work in mathematics education started. The school was my own school from where I had completed my high school education. It was good to work in my own school as all the teachers were my former teachers and they were happy with me to work together. I thought myself a professional mathematician, and I had been strongly interested in teaching, which was the reason that my head teacher

had the idea of offering me the job. I had set foot in the elementary level as a volunteer teacher for more than six months after my high school examination. That experience made me confident to enter as a teacher in the same school where I had been a student some six years before.

I started one of the most fascinating adventures of my life. Teaching mathematics was an adventure to me. I was carrying my banner of “trained teacher with B. Ed. degree”. I remember well my first day of insight. I entered grade nine with a register, chalk and duster. The head teacher was with me to introduce me to the students.

After introducing to the class, the head teacher left me there and he returned he returned to his office. I asked the students what to start with. According to their choice, I started teaching trigonometry. I drew a triangle on the blackboard and told them to do the same in their copy. I asked them what the type of triangle was. Then I drew three different triangles on the board and asked them to classify them based on angles and sides. The discussion was going on nicely. I told the students to draw a right-angled triangle in their copies. I told them to name the hypotenuse, base and perpendicular with respect to an acute angle. Then I told them to form as many ratios as possible from those three sides (h, p, b) of the triangle. They were a little bit confused in the process of making ratios. I wrote them on the board in terms of p/h, b/h, p/b, h/p, h/b, and b/p. I also named the ratios as Sine, Cosine, Tangent, Cosecant, Secant, and Cotangent with respect to the base angle. I did so much on the first day. I did not care about the time and I did not care whether students were enjoying or not. But at least I did not forget to obtain their feedback which was the only thing I did well in the class, although I assured them to proceed slowly and I took due care with them.

Fortunately, at around the same time I started teaching in sixth grade. This was a wonderful experience. One reason is that the sixth graders were still naive; they went along with me wherever I led them, their reactions were direct, and they made it apparent to me what was working and what was not. Sixth grade was the best place to learn about teaching basic algebra. The second reason was that I met there an excellent teacher (my past teacher), who was ready to accompany me in case I had problems in my adventure. Since then I have been learning intensively, from each lesson and every conversation with students and teachers. I learnt from unsuccessful lessons no less than from the better ones; and mostly I learnt from those lessons that limp in the beginning, and then the right thing was done and they took off.

My Journey as a Tutor

My journey with a narrow trail started in 1987. I had no teaching idea. I had never heard about pedagogies. What is Montessori Method of teaching in early childhood? I did not have any idea about how to start the first day and first lesson.

In the evening after my meal, I was busy with my school homework. Bishal in his fourth year came in to my room with a copy and pencil in his hands. I kept him at my right side. I told him to write whatever he liked on a page. He said he knew nothing. I told him to draw some lines, pictures, trees and so on. He drew a picture and showed me. It was like abstract art. I could not understand. I asked him what it was. He said that it was “Joon Ma Ma”. I told him that if he could make good pictures and read well, “Joon Ma Ma” would be happy and give him more knowledge. He started drawing the next figure. He wasted two/three pages in the trial.

I completed all my homework in two hours. It was almost nine p.m. and the boy started yawning. I told Bishal to recite after me. There were no models to show him or

to play with. I started counting “EK (One)”. Bishal said, “ Ek (One)”. I said, “Dui (Two)”. He said, “Dui (Two)”. Counting continued from one to twenty. We counted once, twice, thrice and …… until ten times. I told him to sleep. He went to bed and I started my own practice of mathematics.

On the next day, I started teaching the alphabets and numbers in writing. I wrote one to twenty in his copy and told him to copy the same on the next line. He could not copy well in his first attempt. I told him to recite the numbers after me. He did the same. Then I sent him to the bed.

On the third day, he could copy a few numbers. I appreciated his writing and he went to show it to his mother. He got a lot of appreciation from his mother but his father was not in the mood to appreciate it immediately. He came to me with a mixture of happiness and gloom.

The routine continued. The ritual of writing and reciting the numbers and the alphabet every evening became his habit. Sometimes he used to be reluctant to write numbers. I used to tell him tales. He was fond of listening to tales. When my tales did not work, I used to give him a slap (though it was not good to do so).

My tutoring of the boy continued for a year. He learnt writing from one to hundred in Deva Nagari and Hindu-Arabic scripts. He also learnt simple addition, subtraction and the multiplication table up to five.

At that time, for me, teaching meant making the boy recite the numbers, write them, add and subtract, write multiplication tables, read and write simple Nepali words and sentences and draw some pictures. I did not have any idea of how to teach a small child. I did what I knew and I did it in a way that the boy could reproduce. There could have been conversation and dialectics that could have played an essential

role in the teaching and learning of mathematics. But these principles were too far from the practice of my teaching.

My Teaching of Mathematics at a High School

I think it should be a winter's day in 1997. The chilly cold with a westerly breeze made me coil up in my bed till late morning. I had to reach my school by 9.30 a.m. I was a bit late that day, as I could not get tempo to reach the school on time. I was just five minutes late. My students were playing outside the classroom. I went in to the classroom without appearing in the office. I sent one of the students to get the attendance register from the office. After taking attendance, the drama of teaching and learning maths started.

I asked Rupak about the day's lesson. He said that it was to start values of trigonometric ratios of standard angles. I made a chart on the board for the values of 0, 30, 45, 60 and 90 degrees of Sin, Cos, Tan, Cosec, Sec and Cot ratios in tabular form. The chart appeared like this:

Angle / Ratio	0°	30°	45°	60°	90°
Sin	0	$\frac{1}{2}$	$\frac{1}{\sqrt{2}}$	$\frac{\sqrt{3}}{2}$	1
Cos	1	$\frac{\sqrt{3}}{2}$	$\frac{1}{\sqrt{2}}$	$\frac{1}{2}$	0
Tan	0	$\frac{1}{\sqrt{3}}$	1	$\sqrt{3}$	∞
Cosec	∞	2	$\sqrt{2}$	$\frac{2}{\sqrt{3}}$	0
Sec	1	$\frac{2}{\sqrt{3}}$	$\sqrt{2}$	2	∞
Cot	∞	$\sqrt{3}$	1	$\frac{1}{\sqrt{3}}$	0

All the students wrote these values in their copies. Udip stood up from his seat and asked me how these values were determined. I replied that these values could be found by geometrical methods. But he was not satisfied. I saw him in gloomy mood and he was looking at me with an unsatisfied look. I told him that at first they have to be rote learned and then we would start solving problem. I told them that geometrical proof of how to get Sin 30° = ½ was not necessary for them at the time.

When all the students finished their writing, I told them to read silently the values of Sin ratio for ten minutes. I moved front and back in the class while they were reading the values from the table. After ten minutes, I told them to stop reading and be ready to reproduce.

I pointed to Sanju and asked, “What is the value of Sin 60°?" She replied correctly with some confusion. Then I pointed to next one, Deepak, and asked, “What

is the value of Sin 45°?" He said ½. I gave him a gentle pat on his head and said, “No, it is one over root two." I asked the values of all, one by one in turn. Some could give the right answer and some were in confusion. I told them to read the same at home. The bell rang and my period in the class was over.

My routine of teaching mathematics continued with the methods and practices as is obvious from above. I did not let my students ask questions. I did not encourage them to do group work or cooperative learning. The class used to be in my full control and the students were passive listeners and copiers. I considered myself as the source of all mathematical knowledge to them. I was a transmitter of the knowledge to them and they were the receivers. Sometimes I used to give physical punishment to the students when I felt that they were not paying attention to my lecturing. How much they received was tested in the terminal and final examination.

Teaching Algebra to Beginners

Mr. Z is going to start the algebra lesson for the first day in grade six. He tells a boy at the first bench to go out and find a few pebbles. Two boys run out and bring some pebbles from the back of the school wall. The teacher starts writing something on the board. He writes 2 +3= [ ] He asks a girl from the middle to fill the fox with a number. She writes 5 in it. Then he writes 3 + 3 = [ ] and asks another boy at a corner to fill the box. He obviously writes 6. The process continues for a while with structures such as 4 + 3= [ ] , 5 + 3 = [ ] and so on till 10 + 3 = [ ]. Then he represents a pebble with x , next also with x and so on till five/six pebbles. Then he writes 2 pebbles + 3 pebbles = [ ]. He asked Bibek to fill the box. Bibek filled 5 in it. He then asked other students to fill the box. Again Mr. Z wrote 1 pebble + 3 pencils =[ ]and asked the students to fill the box. Almost all the students wrote 4 in the

box. Some wrote 4 pebble and pencils. Then he showed the first example putting pebbles and asked them again. Many students did it correct. But when Mr. Z put one pebble and three pencils on the table and asked the students to add, they were not getting the idea. Mr. Z clarified that one pebble and three pencils can not be added. He represented one pebble with a x and three pencils with three y's and told them to write it mathematically, then students were again confused what mathematically meant. Then the teacher writes x + 3y as the sum of a pebble and three pencils. One student, perhaps Suman, asks, "Why we denote pebbles with x and pencils with y?"

It strikes him. Mr. Z answers that they can use alphabetic symbols to denote objects and their numbers. In algebra we use such symbols. The boy asks why to use symbol. Mr. Z says it is custom in mathematics to use symbols, especially in algebra, instead of numbers and objects. Mr. Z gives some algebraic expressions to add. The students are engaged in adding the algebraic expressions. They are for the first time doing such mathematics in their class and outside class was beyond their imagination. Mr. Z finishes discussion in the first day of the algebra class and gives some questions as homework for students. Mr. Z returns to his office. He feels a difference on the day after returning from the classroom. He thinks that grade six should be easier to teach since they are the beginners in the algebra.

I think that it is the pedagogy of teacher to adopt appropriate methods of dialogue, discourse or interaction among students, teachers and parents. To me, Mr. Z might have thought that he teaches very well and he makes students keep pin-drop silence in the class. He keeps his students well disciplined. The sixth graders are relatively more difficult to control as they do not understand the abstract nature of mathematics, they start buzzing. I feel that Mr. Z may have been thinking that he is a good mathematics teacher and mathematician. But there are things that he still needs

to learn while teaching. Why are pebbles denoted by x's and why are pencils denoted by y's? The same question echoes in his mind, soul and thinking. He turns to an algebra book written by an Indian Author to find the cause. He tried to ask his own teacher in the same school but could not get a satisfactory result. He then thinks, "Knowledge and understanding are relative". Absolutist knowledge and reality is the hindrance in mathematics education. He thinks how can pebbles be represented by x and how can the pencils be represented by y, it is a kind of representation in mathematics. Mr. Z finds complexity in simplicity and simplicity in complexity. It simply depends upon how they are treated with students and how students make meaning out of those things.

My Teaching of Mathematics at Under-Graduate/Graduate

In my journey through teaching and learning I started teaching in Under-Graduate/Graduate level since 1998. I remember how I practiced my teaching mathematics at that time. Sometimes I had to practice some problems twice and thrice before discussion in the classroom. Images of students come infront of me and ask me, "Mr. Belbase, will you teach us modern mathematics?" Some of them ask me how to prove Maximum Likelihood Theorem in Inferential Statistics. The poet inside me started typing the following lines:

In front of galaxy of luminaries
Metaphor of learners and learned
I stood as vending machine
To transmit the mathematical series
Mathematization in a basket

Axioms, theorems and proofs
I try to portray in my canvas
A world of tomorrow’s casket
Canter's theorem, abstract and cool
Students ask me how to get it
Euler's formula 'n' Vogel's approach
Dilemma, try, repeat and befool
With unearthed to transparent
In symbols of abstract to concrete
I am counting uncounted smiles
At a door of heaven with fervent

Teaching mathematics at undergraduate and graduate level was more challenging to me. I had to make my students understand the things clearly though it was not much clearer to me during my previous study. The students were as illuminating stars for me and I had to shed more light on them and make them brighter. I used to transmit- mathematical knowledge to them as it was difficult to construct meaning at the time. I was still guided by teacher-centered lectures. I was as vending machine bringing mathematics from books (compilation) and selling (transmitting) to the students. Some more abstract theorems fooled me as I had to show them diagrammatically. I think, I was making caskets of mathematics on the canvas of the present because my practice of teaching mathematics at the time was not guided by the principles of critical thinking, reasoning and constructivism. I tried my best to bring the hidden meanings into reality with symbols and models.

Confession

Once in May 2006, I was thinking about my pedagogical practices since beginning of my teaching career. I remembered the mistakes I made and how easily I managed to hide them from the eyes of students. I remember how I was befooled myself when a very easy problem sometimes took a whole period and remained unsolved but suddenly came into mind on the way returning from school. The poet inside me came and typed the following lines confessing the wrong practices at the time and promising a constructivist teaching and learning of mathematics to be continued.

A gentle hum
Group and group
Helping each other
Some in discussion.
No fear and no gloom
Measuring a cylinder
Sharing of ideas
Finally got the volume.
Am I at idle?
No, no and no.
Helping them do
Getting to the final
Now I facilitate
They do this and that
I go to them
When they confiscate

I feel, my practice of teaching mathematics from beginning to now was a journey along many ups and downs. I think teaching mathematics was putting me in a

heating chamber where the more I was heated; the more I got purified in my pedagogy. I learnt many more ideas of teaching mathematics on the journey. I confess my poor methods of teaching at the time. I feel now that I received more a heating during the course of this research and reflection, which made me confess my teaching style in the past and follow a student-, centered approach. Certainly this can be a good finding of the research and a good practice of confessing one's own deeds for more constructive and creative practices in the future. Research should be for improvement or change. So, this will change my pedagogic practices.

Ways Ahead: Future of my Pedagogy

After my confession, I would like to draw an immediate line in the process of pedagogic metamorphosis. So, I think the following map should be my steps ahead. My journey should follow the cooperative learning principle and pedagogic enrichment should incorporate critical and creative thinking with constructive approaches. I agree with Ubiratan D' Ambrosio (2002) as he feels that now the time has come to do some creative work for the people's mathematics, creative practices of mathematics in the social and cultural contexts. Ethnomathematics can be a door to view the people's mathematics in their socio-cultural context. Ethnomathematics is particularly concerned with real contents, and this is implicit in the way we deconstruct the word ethnomathematics: ethno + mathema + tics (techne). The restoration of this in education is implicit in his proposal for a modern trivium in education: literacy, matheracy, and technoracy (D' Ambrosio, 2002).

D' Ambrosio states that pedagogical action of the ethnomathematical program underscores the importance of doing the ethnomathematical work first. In this context,

coming to a good understanding of the mathematical aspects of culture and having a clear purpose to the educational activity are vital aspects of this perspective. I think the consequence of these ideas is that ethnomathematical work in the schools is not a simplistic presentation of cultural examples or simply situating mathematics in cultural contexts (D' Ambrosio, 1993). Rather it requires considerable background work, complete understanding, and pedagogical sophistication. To me, this is a complex task, takes time, and is difficult to get right. For example, it is convenient to state that teachers may interpret an ethnomathematical approach by starting with the students' outside socio-cultural-economic realities, but the students may refuse to study their own realities because they consider them oppressive. In this case, as D' Ambrosio (1993) states they may not identify this contextualization as mathematics because they already have a grounded mathematical conception as a previous knowledge. So I think in this context, one possibility is to start with the students' existing mathematical conceptions, even if they are traditional, because this is another way to develop the mathematical contents followed by a critical examination of these conceptions. The consequence of this educational aspect for teacher education is significant. It means that teachers must know more about mathematics and additional pedagogical skills in order to help students undertake a critical examination of the mathematical contents (D' Ambrosio, 1997).

How to popularize mathematics by improving its public image can be another issue and we have to work for this too. To me, unless people have a positive attitude to mathematics and unless mathematics education can address the need of the people, it will be a subject to serve the elites by keeping the majority in an underprivileged. I think that this is a cause of social injustice, inequity and root of the class struggle.

Pedagogical Metamorphosis

In my understanding pedagogical metamorphosis is not a one time process. It takes long time and a lot of practices for the effective modifications and transformations in my understanding, attitude and practices. This is a gradual process and I think it is continuing phenomena till the end of my life. There is no end point and there is no perfection level.

I would like to show the stages of the metamorphic process in my teaching of mathematics since the beginning of my teaching as tutor to …. till the date.

This table depicts my stepwise pedagogical metamorphosis in my educative process.

Stages in Metamorphosis	Characteristics
Tutor (Eighteen years before) ↓	Almost no idea of teaching and learning methods. One-way transmission of knowledge. Full control of tutor. Teaching meant transmitting and learning meant reproducing. Motivation by negative reinforcement. Very tittle positive reinforcement. No idea of psychological factors of learning. Strict discipline. Monotonous teaching and learning. Idealist philosophy as close to practice.
Mathematics Teacher (Ten years before) ↓	Little idea of teaching and learning. Some idea of psychological theories of learning. Mostly one-way transmission of knowledge. More lectures and less discussion. Direct instruction More control by the teacher. Transmission and reproduction of knowledge. Positive reinforcement was frequent. Physical punishment was occasional. Strict discipline. Little focus on weaker section class. Do or die no more cooperation. Realist philosophy as close to practice.
Mathematics Educator (five years before) ↓	More idea of teaching and learning. More awareness of psychological factors. Both one-and two-way transactions. Lectures more and discussions less. Locus of controlling the class lies with both the teacher and students. (mutual share of responsibilities) More transmission and reproduction with weak understanding and construction of meaning by students. Neutral reinforcement. No appreciation, no punishments.

	No issues of discipline. Friendly relation. No consideration of diversity of students. Cooperation based on situation. Objective knowledge, behaviorist approach of teaching and learning. Research paradigm was objective structuralism. Experimentalist philosophy as close to practice.
Mathematics Teacher/Educator (One years to now) ↓	New ideas of teaching and learning (Social and radical constructivism, post constructivism). More awareness of students' autonomy. Transmission, transaction and construction of knowledge. Less lectures and more discussions/ Constructivist approach. Locus of control lies with both teacher and students. (mutual share of responsibilities) Students do, teacher facilitates. Positive reinforcement. Students' efforts are duly appreciated. No issues of discipline. Friendly relation. Full cooperation and encouragement. Little attention to the follow up of the plan. More flexibility in the implementation of teaching and learning plans. More focus on pedagogy and less on andragogy. Subjective knowledge, constructivist approach of teaching and learning. Research paradigm is towards subjective constructivist and post-modernist views. Experimentalist philosophy as close to practice.
Mathematics Educator/ Researcher (Now and hence forth)	New approaches of teaching and learning. Full autonomy to the students. Research /case based teaching and learning. Continuous assessment. Reflective practice in teaching /learning and research. Subjective humanistic perspective of finding new knowledge through research and experience. Pro-people, social and cultural mathematics teaching,

	learning and research with the view of global and local needs. Popularization of mathematics education through new vision, mission and goals of mathematics education for twenty-first century mathematics teachers. Investigation of people's mathematics in Nepal and analyze its curricular relevancy. School mathematics support programme of KUSOED and other agencies (DOE, PABSON, UNICEF and others). Existentialist philosophy as in practice and on going.

When I started teaching Bishal simple mathematical concepts starting from number, I taught him as if he was an animal with an empty mind (Tabula Rasa). I could not understand his pre-concepts about the objects around him. Perhaps I could have told him to count how many cows did he have? How may trees were there at the front of his house? How many guavas did he eat in a day? How many steps were there up to his upper flat? How many rooms were there in his house and how many stars could he count in the sky at night? What was the shape of a water pot? What was the "Nanglo" like? How much does a packet of sweet cost? And many more questions could be asked in teaching numbers and counting.

These questions did not come to me at the time. I was teaching him mathematics in a mechanistic way and making him like a machine that could produce things only when inputs were fed in. I did not have the idea that "Teachers must help children construct and elaborate upon what they already know, so they can re-invent mathematics for themselves. A reflective teacher helps the child discover and communicate ideas that would not have occurred spontaneously without the adult's help" (Vygotsky, 1978 as cited in Smith, S.S., 1998). How could I know what Vygotsky or Piaget said about how children learn mathematics? I think my educational practice was so primitive that I was no more than a reproducer myself. I

was not able to understand the philosophy of teaching mathematics, the psychology of the young child or the pedagogy of teaching the child to make him a critical thinker, creative problem solver and constructive social participant. Once the boy asked me, "Why does Chinda not go to school?" I replied to him simply – "He has been born to work on your farmland."

Chinda could not go to school. He was almost ten years old. He used to come to Bishal's house with his father and assist in his work by herding goats. His fate was to work at others' houses. Though school education was said to be free, his father was not able send him school. After a year Chinda got married and his wife came to work in Bishal's kitchen. My pedagogy of teaching mathematics could not encourage Chinda to join school. My pedagogy could not make many Chindas free from that indirect system of slavery.

Still today, many Chindas are out of school, they are out of home and they are out of the mainstream of the social system. They are in "camps" but they are not refugees. They are in "camps" but they are not "travelers". They are in "camps" as they are "landless". My pedagogy is still with a question mark? Then, I was a young high school student just practicing teaching Bishal as my only student. But now I am doing Masters Research on pedagogical metamorphosis, but still, my pedagogy is unable to bring Chindas into their homes, into the mainstream and into social justice and equity. I might have some pedagogical metamorphosis in teaching to the "Bishals", which is the main discussion of my research as it is the main theme is the research topic. I am extremely sorry that I could not involve "Chindas" in my paradigmatic shift process. Hundreds of thousands of "Chindas" are still out of reach of school, and they are somewhere child laborers and street children. I am sorry

“Chinda!”, my pedagogy is not within your reach and you are not within my reach too.

I believe that a philosophy of education becomes significant at the point where educators recognize the need to think clearly about what they are doing and to see what they are doing in the larger context of individual and social development. So, I think, it would be better to discuss my philosophical referents about how those philosophies have been brought into the metamorphosis of my pedagogical practices.

Philosophical Referents of Metamorphosis

I think that teaching of mathematics is guided by the philosophical beliefs of the teacher in a direct or indirect way, from known or unknown practices of philosophy. One might have been practicing teaching mathematics in a philosophical line though he/she does not have any idea of the philosophy. A personal philosophy of mathematics education ascertains the way we learn and teach mathematics within the classroom and the school environment (Southwell, 1999). If mathematics is, as the Platonist tradition suggested, just an entity out there waiting to be discovered then it will be enough for schools to present the curriculum instruction as a mere collection of facts, definitions and algorithms. In that regard, I think that teaching mathematics would be like just transmitting an immutable body of knowledge that students have to accept as a perennial fact without any reasoning. This happened in my teaching at high schools. I did not consider that my students might have some better ideas and experiences to share with me and among themselves. I thought that my students should produce the exact answer and there was no room for partial right or wrong but logically thoughtful. To me, mathematics was infallible and there could be no

alternative in pedagogy and practice. However, if mathematics is a cultural, creative and empirical activity then learners are in the position of constructing their own mathematical knowledge regardless of how different their methodology may be from the canon of orthodox and classical mathematics (Handle, 2000).

History shows that, to me, the first attempts to secure an error-proof methodology of mathematics started with the Ancient Greeks. I think it was Euclid (365-275 B.C.) who dared to explain mathematical reasoning through a consistent network of postulates, corollaries, axioms and theorems (Handle, 2000). For nearly two millennia, the academic community used Euclid's reasoning model to advance mathematical knowledge. However, it was mainly Lobatchevsky (1793-1856) who dethroned Euclid's infallibility by proving that the fifth of Euclid's five postulates was not absolutely true (Baldor, 1984). Subsequent developments in mathematics showed that conventional methods of mathematical proof led to other paradoxes and therefore the search for an alternative infallible method became central at the beginning of the twentieth century. Consequently, three paradigms were advanced to secure the foundation of mathematics, namely, logicism, symbolism and intuitionism, and they became known as the foundationalist movement.

In my understanding, logicism is basically a form of Platonist realism. In this, mathematics is seen as a set of abstract realms that exist externally to human creation. According to logicists, all mathematical concepts can be reduced to abstract properties that can be derived through logical principles (Handle, 2000). According to Handle, logicism has been criticised because of its failure to enunciate an unerring system of mathematical truth, its discourse lacking appropriate discussion of basic mathematical concepts such as plane, line, sets and so on. Logicism has also been criticised for its

obsession with strict logical reasoning, leaving little room for intuition and conjecture which many see as powerful generators of creative thinking (Goodman, 1986).

It seems that formalists share the logicist view that logic is necessary, however they argue that mathematical knowledge is brought about through the manipulation of symbols that operate by prescribed rules and formulas and whose understanding should be accepted *a priori* (Handle, 2000). I feel that formalism has been criticised because of the little space left for creative thinking. The criticism is due to the unfeasibility of creating an inclusive mathematical system due to the need for a related extensive list of definitions, properties, rules and the like, and the reifying of the mastery of mathematical symbolism over meaningful inference and intuition (Handle, 2000).

So far as the intuitionist tradition is concerned, mathematics is conceived as an intellectual activity in which mathematical concepts are seen as mental constructions regulated by natural laws (Handle, 2000). These constructions are regarded as abstract objects that do not necessarily depend on proofs. Brouwer, the founder of Intuitionism, rejects the classical stance of categorising proofs as either true or false and instead argues that other possibilities for claiming mathematical truth should be allowed as academically acceptable. For Brouwer, mathematical induction comes before and it is independent of logic. Likewise, intuition and imagination are seen as early and necessary psychological stages in the process of invention. The main critics to intuitionism, in my point of view, argue that mathematical constructions are not only mentally but also socially constructed. To me, these critics also argue that absolute freedom of thought is detrimental to mathematical rigor. It has also been said that intuitionists' biggest downfall lies in enunciating their theory using formalist methods (Goodman, 1986).

It seems that the crisis and failing of the three traditions in securing mathematics as an abstract, absolutist, universal and infallible system was followed by an increasing interest in exploring mathematics as an activity which was practical, fallible, situated and socially and personally constructed. This movement was labelled "quasi-empirical" because it proposed that mathematics did not actually belong to the category of hard sciences such as physics in which something out there is to be discovered. Instead, mathematics is a human creation born of and nurtured from practical experience, always growing and changing, open to revision and challenge, and whose claims of truth depend on "guessing by speculation and criticism, by the logic of proofs and refutations" (Lakatos, 1976, p. 5).

According to Polya (1986), mathematics is both demonstration and creation. I think demonstration is achieved by proofs while creation consists of plausible reasoning that includes guessing. To me, mathematical methods therefore are not perfect and cannot claim absolute truth. Mathematical truth is not absolute but relative because in fact truth is time dependent (Grabiner, 1986) and space dependent (Wilder, 1986). So far as I have understood, time dependent because what is scientifically true today might be a falsehood in the future as theoretical assumptions change, as occurred with the theories of Euclid and Ptolomeus. Mathematical methods are also space dependent because different peoples and different cultures have different ways of doing and validating their mathematical knowledge (Ascher, 1991).

It seems to me that the transition from the foundationalist approach, with its emphasis on pure mathematics, to the quasi-empirical approach was followed by a renewed interest in the application of mathematics. As seen above, for the foundationalist, the realm of mathematics was made of abstract constructs, a fact that

took them away from an emphasis on application of mathematics (Robitaille & Dirks, 1982; Rogerson; 1989).

In my understanding, foundationalists' overvaluing of pure mathematics neglected the fact that the origin and goal of mathematics was the search for solutions to humanity's proximal environment. To me, in fact, one of the merits of Euclid's geometry is that he designed his deductive method from empirical evidence (Baldor, 1984). It seems mathematics therefore had grown parallel to and in serving the so-called 'hard' sciences. It is this practical and interactive experience to which mathematics owes most of its greatness (Putnam, 1986). For Putnam (1986), the greatness of mathematics did not reside only in its ability to go beyond the realm of concrete entities, nor in the beauty of its proofs, but in its associated power in providing practical solutions to the confused people.

Philosophy and Pedagogy of Mathematics

It is accepted that there is great influence of philosophy of mathematics on the pedagogy of mathematics. The formalist and logicist paradigms, as Hersh (1979) and Rogerson (1994) have argued, have had a strong influence on mathematics education in the twentieth century and therefore have shaped the way teachers and students have learned what mathematics is (Handle, 2000). "Behaviourist perspectives on education have certainly been part of the foundationalist legacy which influenced the school mathematics curriculum and models of teacher education in the world "(Laurenson, 1995; Moreira & Noss, 1995; Robitaille & Dirks, 1982; Thom, 1986). "Knowing mathematics is doing mathematics" (NCTM, 1989, p. 7) reflects the quasi-empirical approach.

I feel that the quasi-empirical approach parallels in many respects the main tenets of the socio-constructivist theory. Although the former constitutes a philosophical view of the nature of mathematics, the latter focuses its attention on the psychological underpinnings of teaching and learning mathematics (Handle, 2000).

For many years, there has been a debate in education on the advantages and disadvantages of socio-constructivism and behaviorism. To me, these two philosophies of teaching and learning mathematics can be depicted as two contrasting views, and both have influenced the way mathematics is being taught in schools (Marland, 1994).

In my understanding, teachers are directly influenced by philosophy of education and that can be seen in his/her teaching practices in the classroom. I have realized that the different philosophical foundations guided my teaching of mathematics since the beginning either knowingly or unknowingly.

Following are selected philosophies of the teaching of mathematics that provided guidance to me in developing my framework of teaching and learning mathematics. For me, these philosophies have a great role in the process of pedagogical metamorphosis.

Idealism in Teaching Mathematics

To me, idealism as philosophy of mathematics education is the practice of a belief system considering the mind as the center of learning mathematics. I think, it gives stress to the mental development of the pupil and it is the primary goal of idealist philosophy. “Mathematics curriculum is viewed as a part of the general education curriculum. Abstract content is prized higher than that which is concrete and semi-concrete” (Ediger, 1996). In my understanding, an idealist mathematics

teacher tends to emphasize mental endeavors as being superior to the physical and its emphasis. Thus the mathematics teacher needs to stress pupils attaining abstract content in mathematics since this will aid mental development. Higher cognitive level objectives need to be selected and implemented in the mathematics curriculum and teaching learning process. Ediger (1996) says, “Critical thinking in mathematics curriculum stresses mental development. Reason and intelligence are necessary to achieve fully in mathematics. The rational being then becomes increasingly mature mentally to use intelligence in dealing with the world of number and numerals.” So, the teacher stimulates pupils to achieve these using a variety of learning opportunities, emphasizing inductive and deductive methods of thinking. In my understanding, idealists stress the concept of purpose for each human being in a purposive world. From the idealist’s view, to me, there is purpose involved in learning mathematics.

My position in teaching a boy to develop his mental skill by reciting numbers and multiplication tables, and enough practice in addition, subtraction, and the multiplication with division algorithms evidences an idealist perspective of teaching mathematics. Bishal learnt to rehearse reading and writing of mathematics through a strict discipline and guided by spiritual motivation. I taught him simple mathematical processes some linked with real objects, mostly paper and pencil based. I think my teaching was more abstract to him and he could reproduce it even without knowing what he was doing. When he showed me his first drawing, his art, I tried to portray a link to his study with the picture saying that if he studied well “Joon Mama” would be happy. Later, was I portrayed knowing mathematics as please the goddess Saraswati to be a great person in the future? This spiritual belief, a kind of cultural myth, was created to motivate his learning of mathematics, as he was difficult to convince in other ways.

Realism in Teaching Mathematics

So far as I have understood, the mathematics teacher who stresses realism as a philosophy of teaching mathematics believes in using the methods of science in teaching and learning situations. I think, objective evidence, irrespective of the subjective person, is inherent in mathematics, when viewed from a realist's lens. Thus, subject matter in mathematics is true independent of the observer or person. Precision is a key word to use in teaching mathematics, according to a realist teacher. A realist teacher likes accurate descriptions of what exists, Ediger (1996) says. For example, the teacher does not care for a student saying that the temperature of the room is tolerable. Rather, the exact temperature reading is wanted, such as thirty degree Celsius. So, a realist teacher who emphasizes that his/her pupils are attaining well does not satisfy the realist critic. Rather, numerical results are wanted to ascertain how well learners are attaining, such as grade equivalents, percentiles, quartile deviation, standard deviation from mean and other derived standard scores (Ediger, 1996). It seems to me that testing pupils to measure achievement is quite typical of the philosophy of realism. Thus standardized norm referenced tests may be used to gather data on learner progress. In my opinion, in a realist's approach of teaching mathematics, formative and summative tests are recommended to be given to learners to measure their progress in mathematics. So far as I have understood, a realist mathematics teacher desires the objectives of instruction to be stated in measurable terms, prior to instruction. For example: the pupil will find HCF of two numbers by a division method.

According to Ediger (1996), a mathematics teacher who is realist in terms of philosophy of mathematics teaching desires precise objectives for learner attainment.

Ediger (1996) further says, “The teacher matches the learning opportunities with stated specific objectives so that an increased number of objectives will be achieved by pupils”. What is in the learning opportunities then harmonizes with what is stated in the objectives, no more and no less. I think that appraisal procedures harmonize with the objectives of instruction.

To me, the realist’s epistemological views include epistemological monism where it is held that objects are presented in consciousness and epistemological dualism where objects are thought to be represented. The monists define the mind as a relation between the organism and an object, while the dualists identify the mind more closely with the organisms. I think that realists do have a common tendency to view the world as the mechanism described by the physical scientists, and they generally believe in determinism, in orderliness in the universe, and in objective nature. The unifying theory of realism is that knowledge is thought to have a universal character and comes to man through his sensory capacity (Ediger, 1996).

I feel that my teaching in a High School at secondary and lower secondary level was guided by some idealist and more realist philosophies of teaching mathematics, as I demanded exact answers and exact objective change in behavior. My behavioral objective model of teaching mathematics sought exactitude of learning and rehearsing what the students were taught. Episode two of my pedagogical practice might have been aligned to a realist philosophy as the students were taught to reproduce the exact answer. They were not allowed to guess and estimate the values of the different trigonometric ratios. From realist point of view, I was assessing the achievement of students through more objective evaluations in terms of formative and summative tests. I used to ask questions to the students and demand the exact answer

rather than their views or opinions. That made me more objective and positivistic in the epistemological sphere.

Experimentalism in Teaching Mathematics

So far as reality in experimentalism is concerned, to me, the world of experience represents ultimate reality for the experimentalist. The realist believes that one can know the real world as it truly is in whole or in part (Ediger, 1996). From a realist's perspective, to me, the external world exists independent of any observer or human being. According to Ediger (1996), the idealist believes that one can only know ideas about the real world, not as it is truly is. With knowing what is experienced only, the experimentalist realizes that change is all around us. I feel that our perceptions change with time and place and that life in society continually changes. Thus problems arise which need identification. Each problem is life-like and reality based, not fictional. Clarity in problem selection is relevant. Vague, hazy problems do not lend themselves to solutions. Ediger (1996) further says that a hypothesis is developed for the identified problem. I think that the hypothesis is actually an educated guess or answer to the chosen problem. The hypothesis is not absolute but tentative. To me, the hypothesis is then subject to listing in a life-like situation. The consequences of listing of the testing reveal the correctness or the lack thereof pertaining to the stated hypothesis.

Ediger (1996) has explained that problem solving is the heart of the mathematics curriculum of experimentalist teachers. He further says that problems should be based on real-world situations. Utilitarian problems are then identified, not textbook story problems. A practical mathematics curriculum is then in evidence. Indeed, for me, what is useful in the mathematics curriculum is desired in terms of objectives, learning opportunities, and evaluation procedures. So, the everyday

experiences of people in society pertaining to mathematics provide contents for the experimental curriculum. I believe, from an experimentalist's view, that within a mathematics unit being studied, the learners choose problems to solve. Problem solving does not emphasize memorizing of content; rather, content is acquired to gather data to solve problems.

Mathematics teachers need to be creative in thinking about developing and implementing an experimentalist curriculum (Ediger, 1996). So, I think that there are numerous experiences that can be included in mathematics lessons and units of study that emphasize the practical and the utilitarian in life-like problem solving situations.

Episode four in my narrative reflection is close to experimentalism as my teaching was more oriented to problem solving and practice, practice … and practice. My undergraduate and graduate students asked me about effective ways of learning mathematics and I prescribed them practice, practice and practice. Practicing problem solving repeatedly created a mental image of the algorithms in the form of experience that helped them to understand the problem solving. Some statistical problems were brought from real-world situations such as the average of scores of students in a class, standard errors, hypothesis testing and in operations research.

Real analysis and linear algebra was abstract but the students were taught to frame the criteria of needed axioms, postulates and definitions. Then they were told to practice theorems and understand them with the frame of defined criteria. This gave an experience of problem construction and deconstruction. This experience was long lasting after repeated practice. So the students liked this technique and they followed it. They were practicing the algorithms in their own way and building a connection with previous definitions, axioms, postulates and theorems. But sometimes the experiences led to a nowhere situation and it was difficult to bring the students to their

previous experience in order to link with the new experience. The mechanistic approach of practice, practice and practice might not have helped in creating real experience and it led to mechanical experience rather than constructive experience. The students were not able to transfer the learned ideas to other situations. There was poor interdisciplinary connection of learned experiences. I could not help them to be critical or to reflect upon their experiences and search new perspectives of using experiences for further construction of new and advanced experiences.

They were seeking more tabloid ways of knowing and practicing. The students were not interested in searching for ideas and applying creativity, rather they always demanded the unique solution to a problem. I could not guide them to be critical and creative. Exam, exam and exam dominated their minds and they were easy to guide in that way. So, I did not bother to waste my time and effort by giving them more creative and open-ended questions. Repeated practice was the only way to sharpen the experience and be able to reproduce during the tests.

Existentialism in Teaching Mathematics

To me, existentialists stress the individual choosing and making decisions. To be sure, it is very salient that each pupil learns to engage in making choices. Life consists of making choices. Experimentalism emphasizes also that pupils choose and make decisions, usually within a committee setting (Ediger, 1996). I think the belief exists in experimentalism that a pupil is a member of society presently and should be actively involved in the mathematics curriculum, but within a committee setting. By contrast Existentialism emphasizes the individual as one who should determine his/her curriculum within a flexible framework. The teacher assists the pupil in achieving the latter's goals. Ediger (1996) states that individual pupils should be

heavily involved in determining goals, learning opportunities, and evaluation procedures in mathematics. I truly believe this to be a difficult method of teaching, but certainly have its value and benefits. In all of teaching, it is the learner that is the focal point of instruction. Jean Jacques Rousseau (1712-1776) in his book Emile (as stated by Brubacher, 1996) emphasized a one-on-one relationship between teacher and pupil. Thus a mentor or teacher teaches a pupil. Here, the teacher could truly provide for individual differences (one pupil and one teacher). To me, the learner asks questions that would be of personal interest. I think that the out of doors or nature provides the necessary curriculum for the pupil, according to Rousseau. The teacher then assists the pupil to find the needed information. Induction as a method of teaching is used here (Ediger, 1996). The pupil does not need to depend upon other pupils for help in learning, but is to be an independent being, removed from the ills of society. Actually, in an existentialist curriculum, I think that a pupil does not need to gauge his/her learning against that of others in making comparisons.

I think that existentialists believe strongly in conscious choices made by individuals as being desirable. Moral judgments made in an atmosphere of freedom are a key concept stressed by existentialists. An existentialist mathematics teacher/educator needs to give learners as many options as possible in learning (Ediger, 1996). It seems that the pupil chooses that option in a very open-ended mathematics curriculum. “Most teachers of mathematics would tend to feel that existentialist philosophy is too free of borders and boundaries. Mathematics has its own scope and sequence. The scope and sequence has much agreement in and among mathematics educators” (Ediger, 1996).

Do you prefer closed paper and pencil tests or open book tests? Do you like new or more relevant units of your choice or will we bring some cases for discussion

in class? How is your classroom practice concerning to student participation in discussion? How often do you let your students speak to you or them in the classroom? I designed the schedule, do you want some modifications? I think the proposed plan of action is not suitable to consider for your summative evaluation. Do you suggest any way out to grade your learning? How about your project to consider for final grading, if you agree? Let's divide internal assessment as fifty percent and final project as fifty percent, or something like that. Do want to bring up any new issues for discussion in this class as part of your learning?

More or less, I ask these questions to undergraduate and graduate students in order to actively involve them in curricular planning, assessment and evaluation. My approach is that they should learn to learn and they should develop the level of competency with their active participation in the program. If they are involved in such plans, they think that it is their plan and act accordingly. They feel that the institutional systems are developed through active participation, dialogue and creative discourse of students and faculty members. Open curriculum, flexible learning environment with multitude of options for the students and valuing their effort in constructing scholarly ideas is my latest philosophy of teaching mathematics, and perhaps this is what I have learnt as being a constructivist educator.

In a nutshell, my practice and belief in teaching and learning of mathematics has been continuously guided by the philosophy and metamorphosis is ongoing. It was an egg when I started teaching Bishal, motivating him by a spiritual myth. Then I was more of a realist in my high school teaching, as I demanded exactitude of steps, solutions and algorithm. I was guided by experimentalism while teaching at undergraduate/ graduate level after my Master's degree in Education. My banner was "practice, practice and again practice till you experience it and be able to reproduce it

in your form". In later days, I am impressed by existentialist philosophy that has made me more flexible, with a multitude of perspectives to look at a problem, with pluralistic and democratic practices with mutual participation of students in curriculum framing (modifications), planning, implementing, assessing and evaluating. I feel that a constructivist perspective of teaching and learning is shaping my practice and beliefs and is helping me design lessons to involve my students more in dialogue, creative projects and perspectival reflective practices. I feel that this is the nature of my pedagogical metamorphosis and that it is going on in my perception, beliefs and practices rapidly in later days. The journey under way and there is a long way to go ahead.

Post Modernism and Pedagogy of Mathematics

In my perception, mathematical truths are never absolute and certain, but "should" be understood as relative to a background pre-assumed system, e.g., 2+2=4 is not an absolute truth, since in the system of base 3 modular arithmetic we have 2+2=1 (Ernest, 1998). Sal Moslehian (2002) says that although scientists claim to be guided by rationality or logically defensible ideas, the rules of logic are nothing but socially prescribed ways of thinking. I think that post -modernism emphasizes fuzzy logic as an approach to decision based on "degrees of truth" rather than the usual "true-false". Fuzzy theory resembles human reasoning in its use of approximate information and partial truth. Hence it is ideal for controlling nonlinear systems and for modeling complex systems where ambiguity and uncertainty is common.

From a postmodernist perspective, knowledge, and in particular mathematics, is dynamic and we "should" always be rethinking and deconstructing our beliefs and tools, so there is an emphasis on criticism rather than evaluation. Knowledge should

be free from any dependence on the concept of objective truth; instead, our beliefs "should" constantly be expressed lightly and seen as temporary theories (Generation X, as retrieved from http://www.youth.co.za/genxthesis/ch2.htm). For me, knowledge is characterized by its utility and is functional, i.e. we learn things, not to know, but to use them. I think the significant point in postmodernism is how to see rather than what is perceived. The postmodern scientists are interested in "What might be" and "What could be".

In school education we "should" try, as Rorty noted (Rorty, P. 41-42), to inculcate citizenship, i.e., what children "should" do in order to become "good" citizens, learn social conventions and learn what they need for their everyday lives? School classroom "should" be democratic and dialogical, this means that students "should" have a major say in how their learning is structured and "should" respect their values.

Sal Moslehian (2002) concludes that postmodernism emphasizes teachers and students learning together; in particular teachers "should" help students learn how to learn. A postmodern mathematics curriculum does not stress axiomatic styles, rather it emphasizes problem solving and maybe contains intuitive explanations (representations), computer investigations, metaphors, iterative and recursive procedures, fractals (which are patterns revealing greater complexity as they are enlarged), catastrophes, chaos theory (which is the study of unpredictable systems and irregular and forever-changing complex systems). Postmodern mathematics education emphasizes surface instead of depth, chance instead of design, diversity instead of uniformity, dynamics instead of progress, non-Euclidean geometry as well as Euclidean geometry, category theory instead of Bourbaki's methods. This type of mathematics is about and a part of our life; it is accessible and everybody could learn it and like it.

I think, my journey is on the way and I am trying to follow the foot prints of Sal Moslehian, Ernest, Glasserfield, Fosnot, …… , Taylor, …., Luitel,… and partly with Paulo Freire, Henry Giroux, Generation X. The destination is yet far and difficult to reach and I feel it is at the top of all …..at an eternal infinity. So, the phenomenon of pedagogical metamorphosis continues beyond the stated philosophical grounds and I think it continues to a trans-philosophical and a trans -psychological world of knowledge genesis.

Psychological Referents of Metamorphosis

In my point of view, pedagogy of teaching mathematics has close relation with learning theories. There is a long list of psychological theories of teaching and learning mathematics. It is valuable to look at learning theories from the past and present, and reflect on the many views of learning, to determine the extent to which we have developed in our thinking of mathematical learning and teaching. For me, mathematics teaching was synonymous with traditional teaching, based on behaviorist theory: mathematics has a reputation for being that kind of subject. Ernest (1991) has challenged such a view of mathematics, opening mathematics up to the fallibilistic viewpoint that this subject can be challenged. I agree with Ernest that mathematics teaching does not need to be a straitjacket for teachers or children.

I would like to discuss my practices of teaching mathematics from the perspectives of some learning theories as follows:

Behaviorism

I think Behaviourism is the classical psychological approach of teaching and learning of mathematics. So far as focus is concerned, behaviourism emphasizes the manipulation of external conditions to the learner to modify behaviours that eventually lead to learning. In a behaviourist oriented environment completion of tasks is seen as ideal learning behaviour and mastering basic skills require students to move from basic tasks to more advanced tasks. In addition, learning is considered a function of rewarding and reinforcing student learning. I think, the emphasis is on correct answers rather than on partially correct answers (Elliot, Kratochwill, & Travers, 1996). It seems that inspired by linear programming theories developed particularly during the Second World War, learning and teaching in behaviourist terms is a matter of optimizing and manipulating the instructional environment towards the fulfilment of rigidly and specifically designed educational objectives.

In addition, behaviourists saw the student's affective domain as different from the cognitive domain. The Bloom Taxonomy, for example, classifies educational objectives in cognitive, affective and psychomotor domains (Krathwohl, Bloom, & Masia, 1964). They categorised emotions "as imaginary constructs" that are causes of behaviour (McLeod, 1992). Consequently, behaviourists assume that certain emotions and attitudes can influence behaviour, although, in general, affective issues are neglected (McLeod, 1992). Teachers' and students' minds were seen as "black-boxes" or machines (Shavelson & Stern, 1981) in which attitudes and behaviour occur somehow or even are not relevant (Nespor, 1987).

It has been said that behaviorism emphasizes a process-product and teacher-centeredness model of instruction that has been prevalent in classroom teaching and in teacher education programs in the twentieth century (Marland, 1994). I think a

behaviorist teaching style in mathematics education tends to rely on practices that emphasize rote learning and memorization of formulas, one-way to solve problems, and adherence to procedures and drill. Repetition is seen as one of the greatest means to skill acquisition. To me as a behaviourist, teaching is therefore a matter of enunciating objectives and providing the means to reach those objectives and situated learning is given little value in instruction (Leder, 1994). This over-emphasis on procedures and formulas resembles traditional formalist and logicist ideas.

I think that the theory of behaviorism has had considerable influence on the teaching of mathematics and beliefs about young learners (Worthington & Carruthers, 2003). So, each child is believed to learn best at their own pace through direct teaching and through carefully sequenced steps. Teachers emphasize the need to practise skills and children are encouraged to ‘try and try again’. Learning is viewed as a mechanical result following rewards such as praise or a smile, and children were considered to be passively storing information (Worthington & Carruthers, 2003).

My teaching of mathematics at the beginning (when I taught Bishal) and later in a high school was guided by behaviorist approach. I feel that it led me to the idea of sequenced and individualized subject material broken down into discrete steps.

Constructivism

It seems to me that the constructivist approach came into existence as an alternate to the behaviorist approach of teaching and learning of mathematics. Constructivism in brief, as opposed to behaviorist models of teaching and learning, claims that knowledge can not be transferred from one individual to another in educational environments. For a constructivist educationalist, knowledge must be actively constructed as the learner is an entity with previous experiences that must be considered as a "knowing being" (Fosnot, 1996). Learning is therefore seen as an adaptive and experiential process rather than a knowledge transference activity (Candy, 1991). As learners encounter new situations, they look for similarities and differences against their own cognitive schemata. These contrasts, also called cognitive perturbations, are the end-product of conflictive knowledge waiting to be resolved through reorganizing schemes of knowledge (Phillip, 1995).

In constructivist terms, learning depends on the way each individual learner looks at a particular situation and draws his/her own conclusions. I agree that people therefore determine their own knowledge based on their own way of processing information and according to his/her own beliefs and attitudes towards learning (Biggs & Moore, 1993). Constructivism therefore gives recognition and value instructional strategies in which students are able to learn mathematics by personally and socially constructing knowledge. For me, cconstructivist learning strategies include more reflective oriented learning activities in mathematics education such as exploratory and generative learning. More specifically, these activities include problem solving, group learning, discussions and situated learning (Murphy, 1997; Wood, Cobb, & Yackel, 1991).

In my understanding, Piaget's scientific studies of individual children led to a view of the child as a 'lone scientist'. Piaget viewed children's learning as biological development. Although children were considered actively to construct understanding of the world through interaction with peers and their environment, the overall view was of children working individually and at their own pace (Worthington & Carruthers, 2003).

Piaget's 'four stages of development' and experiments on conservation have been very influential in the teaching of mathematics. Piaget's hierarchical view of learning unintentionally influenced the content and use of mathematics schemes that continue to be extensively used in schools and in some Early Years settings. In the Early Years, this led to a focus on sorting, sets, matching, one-to-one correspondence and classification as precursors to work with numbers that has only recently been questioned (Carruthers, 1997c; Thompson, 1997).

Piaget's work also emphasized the idea of 'readiness': children were not believed to be 'ready' to understand particular concepts until the appropriate developmental stage had been reached. The child's culture, the role of language and social interaction were not emphasized in Piaget's work (Worthington & Carruthers, 2003).

I feel that there was a rare practice of constructivism in my teaching of mathematics in school and university campus level. Once I had involved my students in estimating the cost of an educational excursion. The students of grade nine were divided into groups to calculate transportation cost, lodging cost, food cost and miscellaneous cost. Four groups had worked on it and based on their reports and discussion on it, the excursion had been organized. Students were given the task so that they would feel themselves responsible during the tour.

I cannot find direct evidence of practicing constructivism in my journey of teaching mathematics until a year ago. I was a little aware of student-centered teaching and learning but it was limited to simply problem solving, oral questions and answers and so on. The math classroom practice was one-way communication. I was the transmitter of the mathematical knowledge. The most effective application of constructivism in my practice was in science class while teaching acid, base and salt, some gases, reflection and refraction of light, and electromagnetic and some biological activities. I involved my students in experiments and found out their basic ideas. It was a good opportunity for them to construct meaning out of what they observed, experimented and recorded. But in mathematics, I applied a constructivist approach in teaching geometric constructions and proving some theorems.

I had practiced informal cooperative learning when I was a student at different levels from school to university. But I could not apply the same in the classroom when I was a teacher. In one way , it was difficult to bring such practices into the classroom due to various constraints such as resources and the availability of appropriate classroom. Moreover, my lack of practice was due to ignorance of the techniques as profound methods in my pedagogy of mathematics.

Social constructivism

Vygotsky believed that children actively construct their understanding through solving problems in their own way. Children were believed to have a current level of learning and a level that might be reached with the help of more knowledgeable others (an adult, peer or older child): he termed this second level the ‘zone of proximal development’. According to this theory, the child understands is constructed through talk, social interaction and shared meaning (Worthington & Carruthers, 2003).

So far as I have understood, the theory of social constructivism implies that teachers encourage children to talk about their mathematical understanding. Social interaction is emphasized since individual children construct their understanding through talk and interaction with others. Sharing of ideas and meanings are negotiated with others. Learning that is socially constructed continually challenges learners' thinking and emphasizes the personal meaning individuals make (Worthington & Carruthers, 2003).

In my practice of teaching mathematics, there was rarely opportunity for dialogue in the classroom. The students used to listen to me. Even when I was teaching a single student, Bishal, there was one-way communication. When I was teaching in high school, the students used to answer my questions. Their questions were rare and only if they dared ("How to find the values of the trigonometric ratios?" Bishal asks). There was a thin layer of social constructivist practice in my science teaching as the students were sometimes involved in group work to identify acid, base and salt or preparation of gases and study their properties. In the mathematics class, they were allowed to communicate with each other only in class-work problems given to solve within the class in groups. Such group work and sharing was rare in the day-to-day class.

In the later days of my teaching career, slowly this practice has gained dominance in my undergraduate and graduate classes. My students are demanding more time for discussion and sharing rather than one-way lecturing. This is certainly a metamorphosis in pedagogy. I appreciate their opinion and I change the lecture hours into discussion, sharing and activity hours. The classroom activities these days are more dialogic and interactive. There is student-teacher interaction and student – student interaction in my classes. I can claim that these are some symptoms of

metamorphosis, a phenomenon of positive change in pedagogy to make it more student-friendly and social. I encourage students to ask and to discuss openly. I value the opinions of students and let them create the learning to learn environment. I think that the classroom now-a-days represents a type of social schema and discussion serves as social and cultural phenomena of creating knowledge through dialogue, mediation and compromise.

Sociocultural Perspective

This theory emerged during the 1990s. Compatible with many aspects of Vygotsky's work, Bakhtin (1981; 1986) and Bourdieu (1977; 1991) have extended our understanding of the importance of creating knowledge together and of the central role of talk. The belief is that higher-order functions such as learning grow out of social interactions; therefore, the context of learning is highly significant, whether at home, in the community or in the Wertsch proposes that these new perspectives 'suggest major new ways' to extend young children's understanding of literacy: he concludes that the implications of Bakhtin's theory 'are enormous' (Wertsch, 1990, p.119).

I think, when young children begin to engage in literacy practices, or what Bourdieu refers to as 'exchanges', they bring their excellencies and receive distinctions, they become members of an exchange to be recognized as members of a culture' (Bruner, 1996, p.7). For Bourdieu, literacy is a form of 'cultural capital, in which knowledge is defined as competence that can be converted into status, wealth and mobility' (Luke, 1993, p.7). Bourdieu's description of the participation of learners in these learning contexts is a way of thinking, of negotiating and that is what we need from the start' (Bruner, 1996, p.13).

Viewed from a sociocultural perspective, creating positive learning cultures within our settings will best support children's developing understanding. I think that in such positive cultures, children's own knowledge and understandings – 'their excellencies' – are valued and meaning is co-constructed by adults and children; they will become full members of a mathematical literacy club (Carruthers, 1997a). But it is within their homes and communities that children first learn about literacy.

Epilogue

To me, the teaching of mathematics is part of a socio-cultural phenomenon. So students should be given opportunity to learn mathematics from home, community and society as a whole where school forms a part of the system. In my early practices of teaching mathematics, content teaching was far from the socio-cultural context. Mathematics teaching in my class never incorporated cultural and social phenomena except in rare cases. I think culture is a very powerful means to construct knowledge. The early experience of mathematical learning has a long-lasting effect in one's perception of mathematics. I could not realize that culture and society can be the source of mathematical knowledge and understanding. I could not contextualize my teaching to Bishal, Bibek, Sanju and many others during my teaching at high school and before that.

My present practice of teaching mathematics has not yet fully incorporated the social and cultural phenomena as part of learning mathematics. So, I think my pedagogy should take the path that way. My pedagogical metamorphosis from past to present is not yet advanced and the process of advancement should incorporate the latest theories of learning and philosophy. It should be a journey of *pilgrimage* towards purification, *pilgrimage* towards nirvana and to the peace and solidarity of people. There should be the voice of the oppressed and there should be a banner of "mathematics for all" with equity, justice and supremacy of humanity. Then my journey of pedagogical metamorphosis will be meaningful in a real sense, and a practical sense. A butterfly will start a new life in a new morning in the new world of mathematics.

CHAPTER 5

A NEW AVENUE IN MY JOURNEY

Introduction

In this chapter I have discussed about my experience of teaching and learning of mathematics and pedagogical transformation after entering the School of Education. I have tried to explore how a novice teacher educator and researcher transformed his belief, attitudes and practices of educative process from a traditional approach towards constructivist and post modernist approach.

My purpose here is to share my own teaching and learning experiences in response to my autoethnographic genre of writing as research and learning and theory making. In doing this it is important for me to note that my experiences have been generated in a teaching and learning context of collegial activity characterized by shared belief in holistic approaches to learning, as well as by team collaboration, lots of discussion, mutual respect and support (Cadman, 2002). The learning environment in KU to me has been extremely influential on my work with students fostering the practice of constructivism in classroom practices from the university to schools. I have depicted how I happened to join KU and what practices and beliefs have been transformed within my educative process.

I was conditioned to follow a behaviorist approach in the classroom teaching and learning. I thought myself a good teacher and tried to do very good in the classroom teaching by lecture and a few problems solving but my eyes opened when I joined School of Education. This school became really a new avenue in my journey from where I learnt about constructivism and its application in the classroom teaching and learning. I entered this school as a student, I later on got opportunity to work as

part-time faculty member, then full time faculty member and now a novice researcher. Really, it has been a new avenue to me and my pedagogical and research practices.

A Gate Way to New Avenue

I came back to the capital city in 2005 in search of my new avenue from a remote mountain city of Beni. I got enrolled at Kathmandu University School of Education in M.Phil. Program. I got opportunity to join regular classes almost after fifteen years though my study in bachelors and master's classes were regular principally but practically I rarely attended the classes. I had been a tourist student in those levels. To be a tourist student is really a very painful experience in life but at least it is a good opportunity in Tribhuwan University to continue study no matter we attend classes or not. I think that only I was not a tourist student; there were thousands of tourist students in the university. It made me self dependent in study and career development without rigorous educative process.

My Perception to M. Phil Study

I admitted in School of Education, Kathmandu University in the M. Phil. Program. I think that it was an important event in my life. I had never thought of studying and working in this university. I feel that this opportunity changed my mission, vision and strategy of life. I learnt a lot new pedagogical practices together with contents during my M. Phil. Study. In first and second semester I attended the classes regularly.

I was a naïve teacher and educator; though I use to think myself as a good teacher and educator. When I participated in the presentation and discussion, I realized that I was far behind in my pedagogy. I found that classroom teaching and learning were interesting and reflective. I had not thought of such approaches during my educative process.

Classroom practices were more practical and discussion oriented. Though some of the courses were not new for me, I got a lot of opportunity to learn the new ideas of group work, presentation, paper writing, analytical and reflective practice and assessment. I feel that it helped me to transform my pedagogy from traditionalism to constructivism. I think that it was the greatest achievement to me from the course which made me think of my old pedagogy of teaching once again.

Our classroom practice was dialogic and interactive though some contents were not as interesting as I expected. Some of the course contents did not incorporate new ideas, philosophies and practices in the field of educational research. There was no discussion of the nature of inquiry in terms of scientific and positivistic methodology, naturalistic and interpretive inquiry, and critical theory. I think it was most essential to understand the basic philosophy of research practices.

In my understanding the course helped me to explore educational issues related to pedagogy and practices in research. Certainly, this has been a great help to me to be critical, creative and reflective. I think the course helped me to be thoughtful and explorative.

I could build a circle of some colleagues during my study. This circle sometimes organized informal discussion regarding the burning issues of research and management practices. Indirectly it helped me to understand the new approaches of researches, pedagogy and cultural sharing of ideas and opinion. In some classes

presentations were almost one-way communication. The presenters used to present and others were passive listeners. There was no group discussion and open sharing of ideas. This made me feel some courses boring. I did not find the course so interesting at first in the classroom discussion. Though there was dialogue, interactions and presentations, the content did not cover the recent trends and issues. The contents were of old modality and the courses were not enough to be proactive planner, reflective thinker and pedagogically thoughtful. The course was labeled philosophy but it did not pronounce a single word of philosophy in the two semesters though it might be common in Foundation of Education. Even then it had some new flavor with interesting activities such as mini-research, project works, leadership case studies and seminars.

My M. Phil. Study equipped me with some theoretical ideas in the field of management, educational research and present issues in education. I learnt some new visions and insights of critical analysis, reflection and management theories. Though I did not get these ideas in direct instructions and classroom practice but the new culture envisioned me those ideas.

Stepping Stone

I think neither it was intellect and nor good understanding of the mathematics education, that helped me to step ahead in my career but it was my courage to accept challenge which introduced me to KU as a faculty member. My courage to do hard work and accept challenge I could continue study of mathematics. Most of the time I read mathematics rather than doing it or practicing it. During my bachelors and Masters degree in education I rarely practiced any mathematics rather I read mathematics books as if I was reading "Lord of Flies" or "The City of Joy". I realized

mathematics rather than memorizing. Though I could not do good as could but it gave me a new insight to understand mathematics and its aesthetic beauty. Reading mathematics book was not less interesting than reading "The Merchant Venice". This was how I read mathematics during my university life.

My teaching style was more teacher centered and one-way communication. When I got chance to participate in peer teaching with Bal Chandra, I got a lot of new ideas about student centered teaching, activity based teaching and constructivist way of teaching. We used to complement in each other's teaching style. I got lots of ideas of recent trends of teaching and learning from him and could bring new ideas in the classroom. After few months he left me to teach in the class with full responsibility and independently.

I have tried to connect my ideas and experiences gained in mentoring by Bal Chandra to the classroom practices to promote pedagogic engagement (Cadman & Ha, 2001). He constantly mentored me about the new approaches of teaching and learning. He gave me books and papers to read about new approaches of teaching and learning. He also observed my classes and suggested for the improvements. So, my pedagogical practices shifted from traditionalism to more recent and latest form that is constructivism. He has left a great impression in my paradigmatic shift from traditional approach to constructivist approach.

I think that possibly the most immediate influence on students' learning is their affective experience of the classroom itself (Cadman, 2005). It seems necessarily true that at the heart of all classroom environments is the personal philosophy of the teacher, including his/her level of commitment to equity and justice as well as to specific educational goals. So the stepping stone of PGDE encouraged me to be a teaching assistant in School of Education with expectations of further career goals and

possibilities to be a lecturer, assistant professor, … … with a degree of Ph.D. in the days to come.

The Turning Point

My role of being teacher educator within critical mathematics is outlined from the view point of novice educator and researcher (Cadman, 2005). I did not dare to ask my seniors at KU why they offered me the position of faculty member. There were university toppers and excellent record keepers in master's degree in mathematics education and pure mathematics. But I was surprised to be invited for teaching as part time faculty member. I didn't think I could teach better than those with colorful academic certificates. I thought I could learn better than them the system of KU, the new ideas of teaching and learning and pedagogic transformation from one-way-traffic to transactions. This might be the reason why I was there to teach PGDE and M.Ed. students. Moreover my friendliness and soft leadership practice might have impressed my 'guru' at School of Education, but I am not sure about it.

In this context there is a need to develop the habit of learning by self, exploring new ideas and sharing among the colleagues so the perspective teachers or educators get enough exposure to constructivism and the contents to teach their students confidently.

I think it was a great opportunity for me to transform myself from traditional teacher to a constructivist educator and facilitator in the route of my pedagogic metamorphosis. I cannot measure the degree of transformation but I feel there is substantive change in my theoretical and practical understanding of new approaches in teaching and learning of mathematics. So, I am trying to portray the change in my educative practices in the classroom.

My practice of teaching and learning in Kathmandu University has brought a major shift in my belief, practice and attitude and also it has impression on my epistemology, ontology and methodology of my educative process through classroom practice and research.

The Way I Started

One day in autumn 2005, I was grooming over the computer monitor to find some teaching materials in the internet. I opened the internet browser and typed www.google.com on its search area. Google search engine opened. I typed "Algebraic Thinking" on the search area. There were lots of sites opened. I opened some sites and tried to find some materials for the day's lesson. I found a reading material on the topic and saved it on the desktop. I got the material printed and then photocopied to distribute it to all the students.

Students came into the class at ten in the morning. I had already kept some cardboard boxes, some pencils, markers, cardboard papers, print papers and a role of masking tape on a table. I welcomed students in the class. I wrote the topic of the day "Algebraic thinking" on the white board. Then I distributed some blank sheets to each student and asked them to write what they knew or thought about algebraic thinking without reading any material. I let them twenty minutes to finish their writing. I facilitated them while they needed my help during the time they were writing.

Some finished within twenty minutes and some could not and I increased five minutes so that all would be able to finish their writing. All of them finished writing within twenty five minutes.

Then I provided them the reading material that I downloaded from the internet and let them fifteen minutes to read and ten minutes to write what they learnt after

reading. They finished reading and writing on time. Then I divided them in four groups with three in each and asked them to discuss in group about what they had thought before reading and what they thought after reading. I let them discuss for fifteen minutes.

The discussion on the topic continued for fifteen minutes. The students shared their views before reading the paper and after reading it. Then they summarized their views in a print paper in three groups. Each group presented their views and opinions turn by turn by fixing the written print papers on the wall.

In the second session I showed three boxes with some pencils in one, and other and some cardboard papers in the third. Then I asked the students in three groups to generate an idea of algebra from each box.

A group wrote an equation to represent the relationship between numbers of pencils in two boxes, next group wrote the concept of index number from the box of cubic shape and another group wrote their concept of inequality from the three boxes. Then they discussed in the group about their concepts of algebra out of those materials. Lastly a member from each group summarized their algebraic thinking about the objects under discussion.

I think how to use technology to find teaching and learning materials has been a very important part in my educative process in KU. I was heavily depended on textbooks and some reference books for teaching and learning. But when I joined KU as a student at first and as a faculty member later, I learnt how to find reading and teaching materials in the websites and how to use them in classroom teaching and learning. Multimedia devices in the classroom teaching and learning of mathematics became usual to me. In my understanding the application of new technology has helped a lot to enhance the teaching and learning of mathematics.

I was not much aware of the teaching materials and activity-based teaching and learning mathematics. When I participated in peer teaching with Bal Chandra, I got ideas of activity based teaching and student centered teaching through various interactions and discussions. I think mathematical knowledge is constructed and acquired actively by the subject of recognition. It is not acquired by transmission or discovery. Enforcement by others becomes detrimental to constructive activity (Nakahara & Koyama, 1998). So, I tried my best to provide the situation to the students to learn by themselves through reflective practices in the classroom.

Nakahara and Koyama (1998) state that mathematical knowledge is constructed by thinking activities reflectively. It is then corrected and refined through social interaction. My students reflected on what they thought about "Algebraic Thinking". I think it was the most important part in constructive teaching and learning. It created a situation of learning, bridging and connecting.

Nakahara and Koyama (1998) further state that viable mathematical knowledge is agreed in groups and becomes inter-subjective knowledge. While students read the paper on "Algebraic Thinking" and then they discussed in-group, they came to a common conclusion in each group through compromise. The demonstration of the boxes with pencils and papers linked algebra with other concepts of geometry and arithmetic. To me, it was a constructive approach of teaching and learning in the classroom where my role was just to facilitate them and encourage them in discussion and sharing ideas.

I think my pedagogical practices in the classroom became more student centered and self reflective. But the assessment part could not become as good as the discussion and reflection in the class. I could not give the immediate feedbacks to the students. The main cause for this is the lack of time and my business to complete my

thesis on time. I was teaching as a faculty member and at the same moment I was engaged in writing my thesis. But I was aware of the assignments and reports of the students.

The Next Step in My Pedagogic Metamorphosis

I started working as full time faculty member in KU since January 2006. It was a milestone in my pedagogical transformation from traditionalism to constructivism. Just one year before the word constructivism was not in my mind. Now I am teaching “Constructivism in Teaching Mathematics” to PGDE students and applying the same in practice in “Instructional Technology” and “Teaching of Mathematics 9-12”. I don’t think I have been an authentic source of constructivism but I think I learnt what constructivism is and what constructivist teacher or educator does in the classroom. This led me to bring transformation in my educative practice, and I think it helped me to understand the meaning of being a constructivist educator and researcher.

The educative practices in KU made me understand what I did not know and what I should know to be a transformative educator and researcher through the changes in the self. Unless I am changed, I don’t expect I can change others. So, I am in the process of pedagogic metamorphosis inside the educative cocoon of KU.

According to the advice of Bal Chandra I read a book “Learning to Teach” by Richard I. Arends (2001). The book is divided into to three parts. The part one discusses about the leadership aspects of teaching. The part two discusses about the interactive aspects of teaching and the last part is about organizational aspects of teaching. The review of the book enriched my understanding of classroom as learning communities, the inclusive and multicultural classroom, classroom management,

assessment and evaluation, approaches of student centered teaching, and school leadership and collaboration.

Where am I in My Educative Journey?

Now I feel that my teaching and learning of mathematics has been guided by constructivism. Theoretically I am strongly convinced of the constructivist approach though practically I am still a novice educator and researcher. The progress towards constructivism is still continuing and the credit goes to my pedagogical and methodological 'guru', Bal Chandra.

I think there are three levels of teaching and learning. One is realist based teaching and learning in which the teaching and learning goes on as it was before. The teacher does not seek new ideas and methods. He or she follows the same technique for years. It is more traditional nature. The second one is the actual classroom teaching and learning based on reality and theoretical aspects. That is to say that it is based on the reality but bring theoretical aspects to link in the classroom teaching and learning. I have tried this way these days. I think I can not follow all the theoretical assumptions in my classroom due to time constraints, resources' constraints and constraints of socio-cultural context. The third level I think is the hypothetical level and is more theoretical and ideal in practice. My present educative practice is a shift from more traditional and realist to more theoretical actualized pedagogy through continuous mentoring of seniors, reading of books and papers and discussion with students.

During the teaching at PGDE I focused on students' participation in the activities, writing reflections and doing group works. Students also demonstrated excellent participation during the classroom teaching and learning. It was like a

workshop when the students were engaged in materials construction, it was like a seminar when they were participating in discussion and it was like training when they were engaged in group activities to share ideas and opinions and summarize their understanding. Almost all were the teachers teaching in reputed private schools in the valley. I was learning myself sharing ideas with them and bringing issues in discussion in the class.

One day in December 2006, I was in the classroom discussing about writing a paper. Some students brought the idea of writing an analytic paper on the mathematics of grade eight. Then we discussed about the mini-project. The students were happy to analyze the text book and curriculum and write a chapter about how to teach it effectively in a planned manner. I discussed about it with Bal Chandra and he liked the idea. So the students were given the chapters to write as part of their project. In this way this led me to understand the role of students in the project identification and writing as part of their assessment of learning outcome.

I remember my mother watching three stars to know the time at night. I learnt how the three stars helped her to guess the time because Polaris was not visible all the nights. Now I am among the three stars at KU to guide me in my educative practices. Some stars are young and some are old but their bright light alerts me of the time and context beyond the past and present. One Polaris encompasses the new direction in my voyage to be a good educator and researcher. Other focuses on my leadership practice and its implication in mathematics education at Kathmandu University.

From the perspective of a student, I learnt some contents, new practices in classroom presentations, discussions, seminar issues and projects. I got opportunity to make a new circle of colleagues working in diverse fields. Sharing of knowledge with them led me to understand more about current issues in education and leadership.

Though I could not give enough time in my study, I think, I learnt a lot in the period of one year in regular classes. More I learnt about new concepts and areas during my research project.

I am doing my research under the able care and guidance of Mr. Bal Chandra Luitel, Dr. PC Taylor, and Dr. Tanka Nath Sharma. The research I am doing is a new one in the Nepalese context after Bal Chandra. I have been learning about new concepts of research. More I write the more I learn. More I reflect the more I understand the nature and process of inquiry in my educative process. I still remember Bal Chandra suggesting me how to start reflective writing. I still remember Dr. Taylor advising me to be careful about pedagogical thoughtfulness, verisimilitude and coherent writing. He also advised me to crystallization of thought and maintain rigor of writing to be safe from triple crises. He advised me to perspectize my writing in first person. His comments on my magical reality in a chapter encouraged me to study in the area of fictive writing, magical and critical reality and lastly hyper reality.

From the perspective of teacher educator I am gaining new insights of teaching and learning. I found myself a novice educator and felt that there was need of more in-depth study to develop my career. It is really a difficult work to change one's own conventional beliefs, attitudes and norms into new approach. So I was feeling difficulty to cope with the new environment at KU. But slowly I got adjusted in the new environment easily. I have been learning some new ideas of critical thinking, creative writing and cooperative working in a team. So in my understanding KU School of Education has been a learning organization to me.

From the perspective of a researcher I have learnt a lot in the process of my research. The traditional methodology has been transformed into postmodern approach. Quantitative research was my essence being a mathematics teacher and

educator but now I think qualitative research is only the way to reach to the depth of reality in a context. Philosophically I was in positivist stand but now I am in critical social approach with postmodernism as my guiding philosophy of research and pedagogy.

In the context of Nepal I think critical pedagogy, transformative pedagogy for intercultural research, ethnomathematics: a dynamics of equity, power and politics of mathematics education, Mathematics Education-Diversity-Constructivism, Democratic Access to Powerful Mathematics Education, Application of Constructivism in Teacher Education, Researching Mathematics Education in the situation of social and political conflict etc can be new areas of my educative practices. In my understanding there are many more issues in mathematics education that can be explored and studied for the equity, access and quality mathematics education for all. I hope my next avenue will bring me to such new areas with more challenges, possibilities and prospects in the teaching and learning of mathematics and research in mathematics education.

My Recent Practice of Teaching

I prepare a brief lesson plan on a page. I search teaching materials and pack them in a box. Some scissors, drawing sheets, scales, sign-pens, marker-pens, a calendar, masking tape and some geometrical/algebraic models are packed in a cardboard box. Dipendra, our support staff, helps me to carry those things in the main building of School of Education. Right at four-thirty post meridian I enter the class. But there are no chairs in the class. Then I start the class in another room. I fix the calendar on the board. I ask the students to guess what activity is going to start. They guess different things but no one pronounced the word algebra. At the same time, Bal

Chandra came to inform us that we can conduct the class in the big room by carrying one chair by each to the room.

I fix the calendar on the board again. I ask the students to choose four numbers (dates) from the calendar in 2x2 matrix form without leaving gap. Then I ask them the sum. One of the students on the first row says 36. Then I tell him that 5,6,12 and 13 are the dates he has selected.

There is a silence for a while and then a buzz. Another student says the sum to be 20. Then I thought for a minute and told him the numbers 1,2, 8 and 9. Some more students tell their sum and I tell them the numbers they chose from the calendar. I write a question on the board, “Determine the algebraic structure of the numbers in the game”. Then they start buzzing in pair. After few minutes some of them say that they can write the structure. I invite one of them to come to the board and write the structure. He does it in no time and it was an excellent example.

I then put another question to them, “Form one more such game from the calendar”. They work in-group. The class is busy in writing numbers in rows and columns in different pattern and form a game with an algebraic structure. After fifteen minutes they present five/six such games from the calendar. I write one more question on the board, “What is the significance of the game in teaching algebra?” They mention some very important points such as – the game links arithmetic with algebra, it helps to form patterns of numbers with algebraic relationship, it helps to be creative, it makes students thoughtful, it promotes learning algebra with fun, it is a way of learning by doing and learning by playing and so on.

What a nice consequence it is of linking the number concept with algebra and patterning to developing mathematical structures. I cheer the smiles in their face. Then I give them a problem on the board, “Suppose that you enter into grade nine at

the beginning of the session to teach algebra. You write algebra on the board to discuss your lesson of the day. At the moment one of your students asks you, “What is algebra?” Now discuss in group how you deal with the class regarding the question and write on the chart paper.

The students in five groups around four in each discuss and write their main points on the chart paper. After twenty minutes all are ready to make presentation. Two students from each group come to the front and fix their chart on the board and make presentations. They write the meaning of algebra in simple and clear form that matches to the level of grade nine. Some of them reach to link some philosophical ideas of explaining what algebra is.

I announced a ten minutes break.

After ten minutes the class resumes. I give them another question, “Assume that you are going to teach factorization in the class after you talk about what algebra is. But you take a survey of their basic knowledge in algebra by asking few questions. You find that majority of them are very poor in algebra and they even don’t know about algebraic expression. You think better stop teaching factorization and rather start from algebraic expression. How do you start it in the class?”

My long question they cannot understand. I explain it again. Then I distribute cards and scissors in-group and tell them to construct some algebraic structures by cutting and folding the paper. Some of them get puzzled and look at my face. I tell them to work in-group so that they help each other. Some students start work but some of them are still in dilemma. I distributed set of wooden blocks or models to represent different basic algebraic expressions such as a^2, b^2, ab, $a^2 + ab$, $a^2 + 2ab + b^2$, $a^2 – b^2$ etc and tell them to work on them. All the students are busy in the discussion

and formation of different algebraic expression with the models. I keep on moving to each group and facilitate in their work when necessary.

Some of the students reflected about their participation in the learning by doing activities by cutting paper or folding it. The wall clock is ready to strike quarter past seven and I give them an assignment to write a reflective journal about their journey of learning about teaching algebra on the day's class. Then the class is over.

I think my start in the lesson seems fine. It is good to start a discussion or lesson from a game. The activities are engaging and creative but still there are lots of things to improve. When the class was over and I was on the way, I remembered that I forgot to summarize the algebraic expression. But I am hopeful that such practices will lead my steps towards constructivism in my pedagogic metamorphosis. Moreover I am hopeful to transcend this approach in other private and public school mathematics learning.

Situating Myself at Kathmandu University

I joined Kathmandu University as a leadership student at M.Phil. Level in February 2005. After six months I joined the university as a faculty member. Now I find myself a novice teacher educator and a researcher in the culture of the university. Metaphorically I am in a heating chamber to be a piece of pure gold. I am confident that under the able care and leadership of my seniors I will be a good teacher educator and researcher in the days to come. I think I am a little volatile and the excess heating may cause vaporize the gold and escape the chamber but it is of less possibility.

In my educative journey the university has become a major agent to transform my beliefs, attitudes and concepts of my lifeworld. I feel myself proud of being a member of the university and I would like to situate myself as a dedicated

mathematics educator with high ambitions of going ahead in the career ladder. I am proud of my gurus at KU who cooperated me to bring changes within my educative practices. I am always with them to bring the university's vision and mission into reality.

Epilogue

I entered the School of Education as an M. Phil. student. I could gain new insights of management and leadership in my educative process. I also learnt new ideas of teaching and learning during my study. More I learnt when I worked as an educator. For me, teaching meant learning to learn. During my research project, I studied philosophy and methodologies research. I think I am a lucky guy to find Mr. Bal Chandra Luitel and Dr. PC Taylor as my advisors in the process of my learning by research. Your able guidance has led me to new vision, thought and practices of inquiring competently and confidently through my personal narratives in the cultural context. I am hopeful that this will open my door to new avenues in the days to come.

CHAPTER 6

CONCLUDING MY JOURNEY

Looking Back

In this journey I moved through my research methodology, learning mathematics in early-days, informal mathematics, formal mathematics, teaching mathematics in schools and university and conducting this research. My journey through autoethnography is ongoing process. But, for me, at this moment the journey of this research has to be safe-landed due to limitation of time and space. This research study is only a part of landscape of my autoethnographic journey.

The data for this study is an ethnographic presentation of myself, a subject considered the 'object' of the ethnographer's interview. Autoethnography is "a hybrid form of autobiography" (Watson, 1997, p. 7). As such, this is an autobiographical work based on a "tentative performance of subjectivity" (Watson). Turning "the ethnographic gaze inward on the self (auto), while maintaining the outward gaze of ethnography, looking at the larger context wherein self experiences occur" (Denzin, 1997, p. 227). Autoethnography allows me to be present both as ethnographer and participant and allows that "writing is a way of 'framing'" (Denzin, 1997, p. 224). I preferred auto-ethnography because it offers an opportunity to explore and understand the complex ideas held by an individual. I think that it provides insight into the reasoning and beliefs of a person. Glesne (1999) defines auto-ethnography as a "kind of writing that inquires into the self as part of a sociocultural context" (p. 181). This methodology lends itself to a qualitative study. It focuses on experiences and allows individuals to explain unique perspectives of their situation. Autoethnography is extremely valuable as they assist in developing theoretical ideas

regarding the human experience and, in this case, educational experiences (Short, 1991). The utilization of this tool will allow researcher to respond in a private manner, yet inform the emerging themes. Auto-ethnography provides an instrument to explore concepts as well provides support for one's responses and behaviors.

I moved through memories of my childhood, school days, university life, a teacher, an educator and lastly experience of being a novice researcher. I tried to go deep inside my childhood days searching some informal mathematics. I found me engaged in many play and games, household activities and socio-cultural phenomena where there were lots of mathematical ideas, concepts and practices. Those play and games laid significant impression to a young mind that provided a foundation to be a mathematics learner, teacher, educator and a researcher.

I encountered with hard days of learning mathematics during school life. I got admission in grade one in Mourighat School, Dang on a day in 1979. My formal journey of learning mathematics started from reading and writing numbers. Mr. Pravat represents my traditional mathematics 'guru' who had mathematics teaching with cold reason and hard control (Taylor, 2005 in classroom discussion). He represents a typical Nepali traditional math teacher in a public school who considers himself as the sole source of all mathematical knowledge. He is a representative of behaviorist teacher who focuses on transmission of knowledge from teacher to students. His way of teaching mathematics was guided by positivist approach. It might be that his teachership was influenced by Hinduism in which teachers are regarded as a form of god "gurudev'.

I agree with Taylor (2005) when he states that we have some cultural myths about mathematics that has hindered in the meaningful learning of mathematics. "Mathematics is hard" was deeply embedded in our mind through culture. My father

once said that if you master mathematics you can be a great person. The young mind perceived that only great persons can achieve mastery of mathematics. This laid a kind of negative impression in my mind during my early school days. Still people believe that mathematics is hard in school. Students scare of mathematics. We are not being able to break the myth and so we are still facing problems of low achievement in mathematics in school level.

I believe that young children possess a substantial amount of informal knowledge about mathematics. The teacher's role is to create a link between their ability to use informal math and the ability to understand more formal math found in grade school (Ginsberg, 1996 as cited in Smith, S.S. 1998). Teachers must help children construct and elaborate upon what they already know, so they can 're-invent' mathematics for themselves. A reflective teacher helps the children discover and communicate ideas that would not have occurred spontaneously without adult's help" (Vygotsky, 1978 as cited in Smith, S.S. 1998). In my understanding mathematics in school and out of school was not bridged across and so it made school mathematics isolated from day to day practice.

I agree with Pahl (1999a) with her claim that children's way of making meaning and understanding the mathematical phenomena can contribute a lot to parents' and teachers' understanding of the complex way that children learn. With reference to Chapter One I am to conclude that there was no link of formal mathematics with informal mathematics during my school days. My teachers did not inquire with me about what mathematical understanding I had concerning day-to-day activities. My learning of mathematics in school was routine work, tedious and not linked with what I knew previously. My learning of mathematics in classroom was governed by powerful cultural myths that restrain the discursive practices of my

teachers and us (Taylor, 1996). Taylor (1996) further states that the power of the repressive myths of cold reason and hard control is evident in the ways in which they act in concert to create a highly coherent and seemingly natural social reality.

The formal structure of mathematics curriculum/textbook did not recognize the way people measure their land, divide the property, distribute local resources in the development, estimate the seeds in farming, create history of their cultural and social values. I never saw my teachers linking my everyday mathematics with number system, fractions, geometry and statistics. The informal mathematics in my day-to-day life and formal or academic mathematics in school were two sides of a river. So, to me an epistemological reform of traditional mathematics classroom learning environments is synonymous with cultural reconstruction (Taylor, 1996).

I have already mentioned in Chapter One that students can deepen their understanding of important social issues such as racism and sexism, as well as ecology and social class (Gutstein & Peterson, 2005). I think that our mathematics has been so sterilized that not our students, but we mathematics educators, as well are not critical about racism, sexism, and economic, environmental and other social issues in our country. What mathematics we studied and what mathematics we are teaching should be a matter of rethinking at least for our future generations.

My idea of how to bridge the gap between the informal mathematics and formal mathematics, epistemology and psychology are closely connected with social constructivism (Bender, 1998). I think it is the teacher's profession to offer the students possibilities for constructing their knowledge and concepts. Although, on principle, the teacher cannot control or fully understand the students' constructions, he or she can judge to some extent by observing how students talk about their knowledge and their concepts, how they apply them or how they build theories with

their help, whether students' constructions match his or her own knowledge and concepts (Bender, 1998). In this sense to me good instruction is nothing else but the preparation of relevant settings as realistic, as well as possibly artificial, parts of the students' experiential worlds, in order to stimulate their construction of knowledge and concepts in the cultural context (Bender, 1998).

From very beginning of my learning mathematics I benefited from cooperative learning. Though it was not well organized and formally set up as group work, I had my own circle of friends in which I shared my ideas and learned to work in-group. It was informal group work but I think that it became my strength in the learning of numbers, tables, operations and patterning. I learnt essential mathematical concepts in my group work. So I feel that cooperative learning can help a lot in the conceptual understanding of mathematics in two ways: first it is easy to share weaknesses and strengths among peers and learning happens obviously in the group interactions. Second way it develops habit of reasoning in the group work, play and games which leads to the critical and creative mathematical thinking.

With reference to Chapter Two I can claim that cooperative learning in my informal group during school to university level was a powerful means to understand the abstract nature of mathematics through discussion and dialogue. Although there was not enough dialogue in the classroom, I was able to form an informal learning group to share ideas and opinions on mathematics. My friends and I found mathematics to be a hard, cold and impersonal subject in school and college. In order to overcome the difficulties in mathematics, the formation of informal learning circle became essential and the need was contextual as our voice was not listened to in our classroom.

The five episodic reflections in Chapter Two portray my practices of cooperating learning from school level to university level. I was not guided by the principle of cooperative learning formally but unknowingly it became powerful referents for my strengthening in mathematics. Gir Bahadur refers to a cooperative member in my learning circle and we shared our views, ideas and knowledge for mutual benefit in our educative process. The shared goals were to solve problems, complete our assignments and prepare for the examinations (Johnson & Johnson, 1989).

From Chapter Two I claim that the first and most important element in structuring our cooperative learning was positive interdependence. The second basic element of cooperative learning was promotive interaction, preferably face-to-face. The third basic element of our cooperative learning was individual and group accountability. The fourth basic element of our cooperative learning was the required interpersonal and small group skills. I think healthy social and psychological development of individuals was the fifth important element of cooperative learning. The sixth basic element of our cooperative learning was group processing.

We were weaker in these aspects at the beginning at school level but these characteristics were dominant at the university level. In this way the practice of cooperative learning in small groups helped me understand the nature of mathematics as numbers and shapes that can be used to tell about things, as logical rules to work with representations of things. Using mathematics to solve a problem helped me to choose what mathematics to use; probably making some simplifying assumptions, estimates, or approximations; doing computations; and then checking to see whether the answer makes sense. All these ideas I learnt from group work in the informal setting of cooperative learning.

From the second chapter I could learn about some theoretical aspects of cooperative learning such as principles of cooperative learning and its application in effective teaching and learning of mathematics in cultural context.

My journey from a tutor to a graduate teacher depicts my pedagogical ups and downs in my educative process. Was there opportunity in the classroom to form knowledge recursively? Was a student provided the opportunity to actively question, revise, and relate ideas in the classroom? In my experience with reference to my reflections in Chapter Three, my answers to these questions would be negative at first and then slowly positive in the later phases. What social structures existed in the classroom to make learning opportunity social? My answer would be that I did not care about the social structures in the classroom at the beginning of my teaching career. But later with my experience I turned slowly to social expectations of students, to some extent though not fully.

Was there dialogue in the classroom? Concerning early experiences, my answer would be that it was rare but in the later period of my career it was more frequent though not dominant. But now it has become a major way to deliver my classes at the graduate level.

In my experience there has been a substantive transformation in my pedagogic belief and practices over a period of a decade. I was a novice teacher with more traditional approaches of teaching in the classroom when I entered the teaching career. With my experiences of teaching mathematics, my pedagogy went on improving from teacher centered to student centered. But I was not guided by new theories of learning mathematics. I did not have the idea of emergent perspectives of teaching mathematics such as sociological, psychological and philosophical perspectives. I did math on the board and my students copied it. There was very little

dialogue between students and me. The communication among students was strictly prohibited in my class.

After five years of teaching at secondary level, I found myself in a different position than before. I started forming learning groups and let them work together. I started taking extra periods during holidays. In those days I encouraged students to be in groups of three or four and work together. It worked nicely. But the practice was difficult in day-to-day formal class due to large size of the class and lack of resource materials.

I think there was a drastic and dramatic change in my pedagogic belief and practices when I started teaching in the university. I had no idea about constructivism a year before but now I can talk about constructivism for hours. I can adopt the constructive approach of teaching in the classroom. Now a days constructivism has been my philosophy of learning, teaching, research and lifeworld. Now I believe that all knowledge is constructed from pre-existing knowledge structures and is recursive and dynamic. This suggests that classroom activities (discussions, workshops, worksheets, projects, etc) provide the student opportunity to use, revise, and build upon previous knowledge (Smith, nd). My next belief is that knowledge construction is inherently social in nature. This suggests an atmosphere that is socially interactive, socially or contextually situated, and influenced by content area norms. When doing mathematics the students learn to emulate inquiry and communicate findings in the manner practiced by mathematicians. Dialogue plays an important role in knowledge construction. What this tenet defines is a social learning atmosphere that is dialogue based.

I agree that knowledge construction is contextually situated. What this suggests for the classroom is that mathematical tasks, projects and assignments

required from students should have different formats (Smith, nd). I think that this depicts my pedagogical metamorphosis from traditionalism to constructivism. Some lessons in previous episodes support this viewpoint.

"Shashidharjee, what research do you want to conduct for your M. Phil. Project?" Bal Chandra, now my research 'guru', asked me on a day in December 2005 at the end of my second semester. A bit bewildered and confused, I replied that I was not pretty sure about my research area and topic till the date. He advised me to read some qualitative research papers and books. I read surfaces of some books – a handbook of qualitative research by Denzin and Lincoln (2005), research methods in education by Cohen, Manion and Morrison (2002), tales of the field by John Van Maanen (1988), Mindful Inquiry in Social Research by Valerie M. Bentz and Jeremy J. Shapiro (1998), etc. I realized that I had almost no philosophical standpoint or philosophical basis for selection of my research area and then research topic. But after reading some qualitative and quantitative research books I could build up some ideas of myself to view the world of research and researchers.

After fifteen days I asked him, "Can a researcher be biased to a context and interpret the reality of the world through his/her experience?" My 'guru' smiled at me and said, "Ok, Shashidharjee, now you are in post positivist school of philosophy." He suggested me to choose a topic from which I could learn something to transform myself and try to give some way to learn for others through my experience. "What could be the possible areas?" I asked him. "I think better you select your research area and topic from your own interest, then only we can share ideas" he replied to me. I asked him to give me some exemplarary research or articles. He provided me some of the course materials that he had used during his Masters of Science in Mathematics Education and his Master's Project.

Within two months I reviewed more than a hundred of papers and reading materials together with research reports and books. I talked with Prof. Dr. Tanka Nath Sharma about my research area in mathematics education. He at first was surprised to hear my research area. He had expected my research to be in leadership but when I told him my objective of selecting the area in mathematics education he agreed and became more supportive of my project. In this way both of my 'gurus' contributed a lot to the change in my worldview and perspective of looking at the research and methodology.

Later on, the arrival of Dr. Peter Charles Taylor to Kathmandu University from Curtin University, Perth, Australia opened a new door for me to enter into the world of qualitative research in autoethnographic genre. On the first day of my visit with Peter, he advised me to carry out research project on my own experience. He asked me, “Are you ready to bear the pain and pang?” I said, “Yes, I can bear any kind of pain during my project.” I further told him that I was a “Tabula-Rasa” and he needed to guide me to fill in my mind properly. I wrote twenty six episodes of my stories of teaching and learning mathematics from early childhood to university level and gave them to him to read. He liked some of the stories and said to me, “Shashi, your stories are interesting and thought provoking. There are so many issues in your stories. You select a few of them for your project.” His patience to read my stories and suggestion to me to go ahead with some selective issues encouraged me to write a dissertation proposal.

Political chaos and uncertainty in the country was being more and more un-rhythmic. I remembered one poem that I had written few years ago when I was trying to console myself in my extreme dissatisfaction with the existing political system.

Days to Come

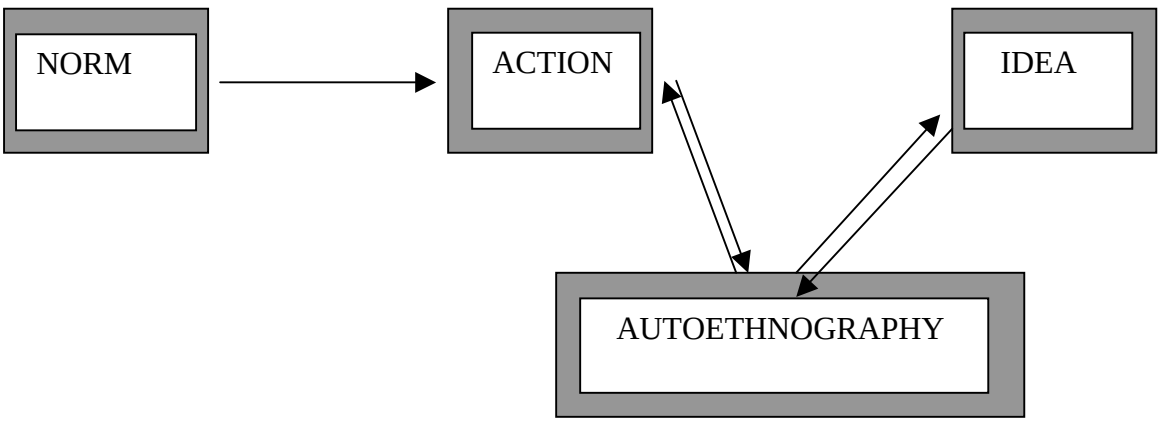
Days passed away
With stones at hand,
Streets moved a way
With turmoil of bang.
I am waiting with eager
Joyful days to come,
Sweet aroma of new blossom
With the days to come.
Ripples of being alive
In storms of blood run,
Hope of existence arrive
At the foliage of days to come.

I felt that I got dewdrops in my foliage of research under the able guidance of Taylor, Luitel and Sharma. My worldview and understanding about reality changed slowly. I was an absolutist and traditional thinker. But the proper guidance of trio and in-depth study of some philosophical foundations of research helped me to reshape my ontological, epistemological, axiological assumptions, to value my own experiences as sources of knowledge and to draw some valid conclusions. Now the sky is going to be clear. The streets are moving with new aspirations to lead the nation

towards a developed Nepal and my poem is going to be meaningful. I think my worldview has been in the process of change from positivism to postpositivism and then to postmodernism.

Paradigm Shift

The diagram below shows how the paradigm shift took place during my educative process in School of Education. There are certain rules or norms as to be followed in positivist approach of teaching-learning-and-research. My own experience became the source of exploring further the cultural terrain and of developing my knowledge and critique of the anthropological perspective. I did not follow the norm related criteria rather I followed rigor criteria in my pedagogy and research methodology that connected my action with ideas through my autoethnography as a genre. But it show to-and-fro relation between action and ideas bridging with autoethnography.



I think that one's experience can be a source of knowledge if it has some unheard rare stories. Knowledge is the basis of the change of habit, attitude and belief and then actions of a person. So the factors that contributed to the paradigmatic shift from positivism to postmodernism are my educative practices at Kathmandu

University School of Education. Basically, my practices of being a student and a teacher at the university contributed to the process of the paradigmatic shift. I did not have any consciousness about my philosophical standpoint as being positivist, post positivist, pragmatist or constructivist and then postmodernist. A famous Nepali adage sangat-guna-phal (fruit as per the companionship) made me change my perspectives of looking at reality, life, and my lifeworld. My ontology, epistemology, axiology and methodology of knowledge construction transformed me from a positivist to a postmodernist, but it is not yet in the extreme degree in the paradigmatic scale. My 'gurus' are the agency of changes in my worldview that ultimately brought some paradigm shift from positivism to postmodernism.

Mr. Pravat in my story represents a mathematics teacher who is from a more traditional culture. His is guided by the culture of cold reason and hard control (Taylor, 2005 in classroom lecture at KU). So, he does not allow us to question him. He has all the power in the classroom. His strict discipline in the class brings the class to a pin-drop silence. His conscience is dominated by the image of a traditional ‘guru’ and he regards himself as the source of all mathematical knowledge. That guided his teaching and our learning of mathematics in school.

My practices of teaching mathematics in the earlier period of my teaching career were guided by the same culture (NORM) to some extent. I was a traditional teacher in the classroom. I did not let my students ask questions and discuss the solution in class. Directly or indirectly the impact of the culture was there in my practices. In my educative practices I visited different places of Nepal and observed different cultures. This made me realize cultural values but I could not bring them into classroom practices. My teaching and learning of mathematics was more guided by the cold reasons of traditional belief systems and cultural practices that students

should not ask question to teachers and the teacher should keep the class in silence while teaching mathematics. Chalk and one-way talk became the main pedagogy of transmitting knowledge from me to the students.

Metaphorically how a fish swims in the river depends on how the water flows. The flow of water is a culture and it shapes the habit of fish in swimming in the river. For me, the culture where I started learning affected my way of learning. In my educative practices of teaching and learning of mathematics, culture was a powerful element to shape my attitude, belief and practices. I was not efficient for female classmates as there was some restriction to be close to female students in school. The school culture did not permit us to be interactive and critical towards the gender issues and various other malpractices in the society that had some bad impression in school too.

The culture of learning mathematics in group became inevitable when I was in high-school but it was limited within a group of some students. The school culture did not help us to promote that activity throughout the school system. There was a cultural barrier in the mutual sharing of ideas between male and female students, in class and outside. That led us to create a distance between students of the same class. I think that there was a lack of border crossing of mathematics learning in and out of the classroom. The culture of learning mathematics had a great impact on my practices of teaching mathematics at the beginning of my teaching career. Slowly my teaching practice was improved as I got some teacher training and experiences of classroom teaching.

When I entered into the culture of Kathmandu University first as a student and then as an educator, I felt a great impression of the culture of the School of Education to shape my pedagogical practices, beliefs and attitude. I cannot say in terms of

quantity to what extent this change has been incorporated in my classroom practices, but I feel that there is a substantive change in my classroom practices and research work.

Autoethnography detached me from norms (positivism) and brought me to actions and ideas (interpretivism). I am not abiding by norms though some norms are still followed during pedagogical practices. I am now more conscious about my actions and generating ideas through autoethnographic genre of writing for research.

Constructivism in My Class

On June 18, 2006 at 4pm I am busy in cutting paper strips and pasting one on another with different color. I pack necessary materials in a box and enter into a classroom right at four thirty postmeridian. My students are anxious to see what I do and to hear what I say. I observe the classroom. Then I observe the students and count to eighteen. I think myself that why other three are absent and fourth has informed me. I know that who are absent, even then I ask some students who are absent and noted in my diary.

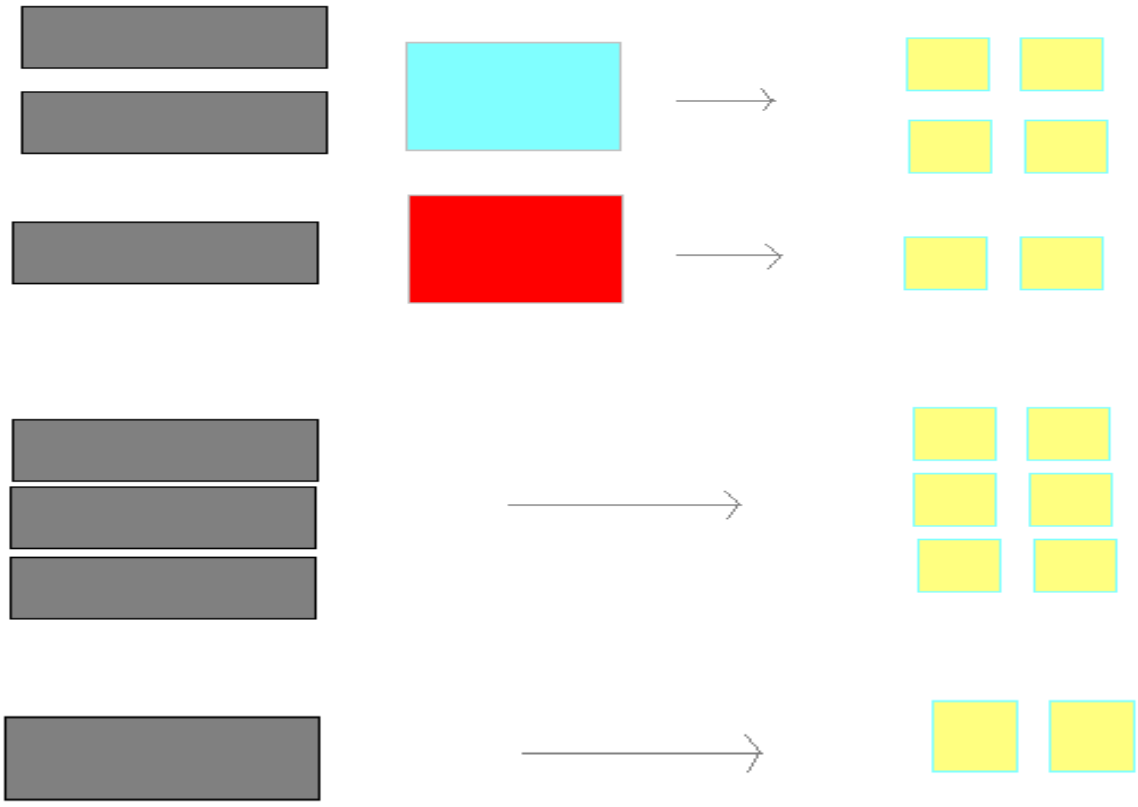
At about four-thirty-five, I put dots on the board with two colors- red and green in rectangular but in alternate form. I call two students Amrit and Laxman at the front to play a game. One of them chooses red and other chooses green color to play the game. They start the game by joining the two dots at a time horizontally or vertically alternately without crossing each other's line but with motive to block other to reach opposite end. After a while one of them reaches to opposite end though his opponent tries to block his path. Laxman wins the game.

The game ends and all the students applaud.

I ask the class, “What is the essence of this game?” One of the students replies that it motivates students. Another student says that it makes the beginning of a lesson interesting as the students concentrate in the game and be ready to go ahead. I conclude the discussion saying that the game provides a kind of spatial understanding and reasoning to select appropriate strategy to solve a problem.

Then I put some colored paper strips to represent equations $2x + y = 4$ and $x – y = 2$. The students help me to paste the strips on the white board. Then I ask the class how to solve the equations. This excites the students. Some say that the equations can be solved by elimination method and some other say by substitution method. Even some suggest graphical and matrix inverse method.

I mix the strips of left to left and right to right and tell them to count. They reply that 3x at one side and 6 at other side. I ask them, “Then what will be the value of each x?” They reply easily that it is 2. I again put some strips to represent $2x + y = 4$. Then I remove a x by two and another by again two. I asked them, “How many pieces are there to the left and to the right?” They reply that five to the left with a y and four to the right. I ask them to remove equal number of small pieces from both sides one by one. Then finally there is no piece left to the right and a y to the left. Students conclude the value of y to be zero.



The black strip represents a 'x', green one represents a 'y' , red one represents '-y' and yellow one represents a '1'. Students apply elimination and substitution method to find value of 'x' and 'y' using the strips as in the picture.

I distribute chart papers, scissors, glue and scales to five groups of students. I ask them to construct such models to solve system of linear equations. The students explore different algebraic structures represented by paper strips. There is a buzz in each group. All of them are busy in cutting, pasting, arranging in pattern to represent different equations and solving them. I move to each group to see what they are doing and explain each-other. All the groups finish their practice by quarter to six.

Then I distribute a sheet of reading text with some numerical information of a school under the heading

"Mathematics in school and school in mathematics". I ask the students to read the paper silently for a while (ten minutes) and reflect on it with reference to a question. One of the students asks me what relevancy is there in the question and the text. I do not give him the direct answer.

I distribute newsprint paper, color-pens to all the students in pair. I ask them to use the information in the text to prepare a teaching plan for a lesson in any relevant mathematics. There is buzz again but this time they are again busy in discussion in group on information in the text about a school and selection of appropriate activity for a secondary or higher secondary mathematics level. All the groups become ready to make their presentations by half past six. They affix their activity plan on the white board. They extend the idea in the text in different forms and brought different ideas.

They make presentations turn by turn. There are nine different mathematical concepts they present. They are: average, percentage, ratio, bar chart, pie-chart, flow-chart, frequency curve, probability and inequalities. They are actively involved in exchange of ideas during presentation. Lastly they evaluate the session and what they learn from the session. I conclude the day's activities with an assignment to read and be ready for discussion in next class.

This is what I learnt in the culture of the School of Education, Kathmandu University. I think these cultural practices of teaching and learning in collaborative, dialogic, activity based and practical education will be helpful to bring changes in the existing school mathematics classroom with the principle of "Mathematics for All". The most important thing is that I have been adapted in this culture to transform my pedagogical practices from traditionalism to constructivism.

Essence of this Journey

I tried to search who am I? I tried to find what I did, what am I doing and what will I do? My journey through autoethnography into my own experiences helped me to find answers of above questions. The journey of this study changed my ontology, epistemology, methodology and pedagogy in teaching and learning of mathematics and research. It helped me to understand my contemporary philosophy, psychology and socio-cultural perspectives in teaching and learning of mathematics. In order conclude my journey of this study, I would like to state what changes this study brought within me and my pedagogical practices:

Ontology: My ontology changed from realist to nominalist. I believed that the real world has hard, intangible structures that exist irrespective of our labels. The social world exists separate from the individual's perception of it. The social world exists as strongly as the physical world. But slowly this ontology shifted towards nominalist view and now I believe that social reality is relative, and the social world is mainly names, concepts, and labels that help the individual structure reality. These labels are artificial creations and we created such realities through our socio-cultural practices. My reflections on learning mathematics as a small child to a university student in Kathmandu University depict these ontological developments.

Epistemology: My epistemology changed from objectivism to subjectivism and conventionalism to constructivism. From the view point of knowledge acquisition I feel that I have been shifted from empiricism (emphasizing role of experience) to constructivism (emphasizing the ways in which learners make meaning from experience).

Methodology: My method of acquiring knowledge or knowing reality changed into an ideographic inquiry that focuses on "getting inside" a subject and exploring one's detailed background and life history. I believe that I involve myself with my normal life, and look at diaries, biographies, observation into my practices. I observed my own life and my practices in cultural context in order to understand my past, present and future. I was a nomothetic and heavily relied more on the scientific method, and hypothesis testing. I believed on the use of quantitative tests like surveys, personality tests, and standardized research tools but this study brought me into the ideographic inquiry that values on subjectivism in inquiry. Autoethnography was the way I reached to this belief and practice.

Pedagogy: My pedagogy changed from conventional teaching and learning to constructivist teaching and learning. I was a more teacher centered teacher and considered myself the source of all mathematical knowledge. But now I am a more student centered teacher and I consider students as active learners constructing meaning themselves from the context. Not only my practice has been changed in classroom teaching but I have changed the teaching and learning of our mathematics classroom in Kathmandu University, and who teaches does not matter but the classes are going to be more student centered. I learnt from constructivist teaching that students should be inspired and involved in exploration, explanation, expansion, extension, exchange and evaluation of a concept they learn. Anybody can see these practices in our mathematics classroom in PDGE and M.Ed. and judge how this study influenced not only my personal pedagogical practices but practices of system can be changed through constructivist leadership.

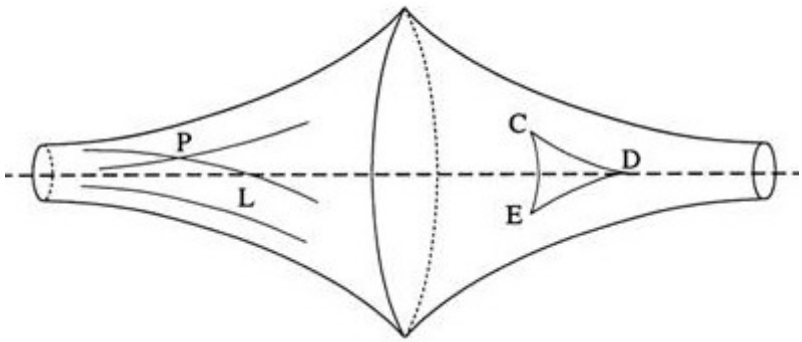
Philosophy: My philosophy changed from idealism to existentialism. I came to realize that personal philosophy of a teacher greatly affects his or her approach to

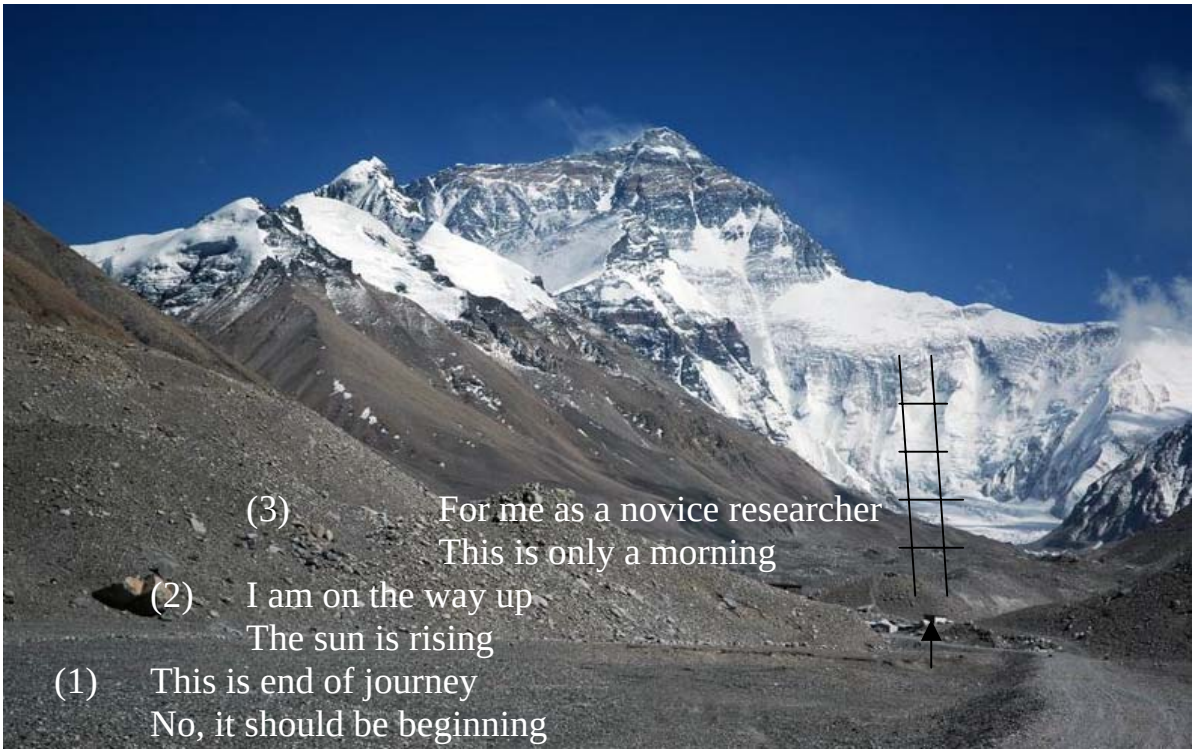
guiding students along the path of enlightenment. I was guided by idealist philosophy and so I believed that my consciousness was the product of mind and everything is composed of mental reality. It affected my pedagogy and emphasized in rote learning of mathematics. But this study made me realize the dualism and pluralism instead of monism. As an existentialist I now emphasize on action, freedom, and decision as fundamental to human existence. I now fundamentally oppose the rationalist tradition and positivism and propose for constructivist tradition in classroom teaching and learning and research.

I would like to conclude this journey with some questions whose answers are somewhere in this report, moreover they can be found in my real practices in the classroom teaching and learning. These questions portray the continum of traditionalist and constructivist teaching and learning of mathematics in my classroom. These questions will guide me in the further professional and academic life.

How did I engage my students in the past and how do I engage them in the classroom these days? How did they involve in exploring ideas in the classroom or outside in the past and how do they explore ideas in or out-of-class now? How did they explain what they explored in the past and how do they explain or communicate their findings at present? How did they expand ideas in the past and how do they link their understanding with real life problems now? How did I evaluate their performance in the past and how do I evaluate the same now?

Panorama of My Journey of this Research




(3) For me as a novice researcher
This is only a morning
(2) I am on the way up
The sun is rising
(1) This is end of journey
No, it should be beginning

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