USE OF MATERIALS IN TEACHING MATHEMATICS

Parshu Ram Kadariya

A Dissertation

Submitted to

School of Education

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DECLARATION

I hereby declare that this dissertation has not been submitted for candidature for any other degree.

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Parshu Ram Kadariya January 30, 2013

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DEDICATION

This dissertation is dedicated to my beloved parents, Mr. Bhawani Prased Kadariya and Mrs. Maya Kadariya, who emphasized the value of education and have a great influence on my life. Also, to my wife Susma Sedai, for her support over the whole period of this study.

Master of Education in Mathematics dissertation of *Parshu Ram Kadariya* Presented on January 30, 2013

Title: *Use of Materials in Teaching Mathematics*

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I understand that my dissertation will become part of the permanent collection of the Kathmandu University Library. My signature below authorizes release of my dissertation to any reader upon request for scholarly purposes.

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AN ABSTRACT OF THE DISSERTATION OF

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My experience of understanding of some geometric ideas was not good when I was a student. But, I was motivated to learn geometry in grade nine when the teacher taught me using bamboo branches. This led me to make students understand surface area of some solids using the same techniques. This background encouraged me to do this research. This study therefore aimed to know 2 Ps i.e. perception and practice of secondary level mathematics teachers on materials in their instruction.

I adopted interpretivism as a research paradigm and ethnography as a research method to conduct the study. I purposively selected six participants from three districts of Kathmandu Valley. I used interview and observation techniques to collect data. I used both semi structured and unstructured questions in the interview as Best and Khan (2007) state that the purpose of open ended interview is to find out what is in or on someone else's mind not to put things in someone's mind (p. 225).

Regarding the perception, in the study, I found mathematics teachers perceived mathematics as 1.a tool which helps students to understand abstract mathematical ideas/concepts/relations. 2. a tool of motivating students towards learning and 3. a tool to instruct students in an interesting way. In the study I found

that teachers prepare materials they use by themselves or supervise students to prepare it and they also buy some materials from the market. They use materials in the beginning of the chapter to develop concepts about the related chapter and sometimes they use during problem solving to solve problem linking with the material. Teachers demonstrate the materials and instruct activities to explore mathematical ideas and to establish mathematical formula.

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CHAPTER 1

INTRODUCTION

Chapter Overview

This chapter deals with my research agenda and articulates my interest as a researcher. It also includes my experience of using materials in mathematics classroom as a student and as a mathematics teacher through which the research questions were raised. Furthermore, it includes my research problem statement, research questions, rationale of the study and delimitations of the study.

The Journey Begins

Today in the world, lesser number of students are being interested in learning mathematics. In Nepal, in the higher level, very less percentage of students are learning mathematics. In Tribhuwan University, hundreds of students enroll in other subjects like Management, English, Sociology, Physics, and Chemistry every year but only a few number of students enroll in mathematics. When I was a B.Sc. student, there were only seven students admitted in mathematics subject whereas more than fifty students were in other subjects. In school education, mathematics is a compulsory subject. In S.L.C. examination, the failure rate in mathematics is higher than in any other subjects. Majority of the students feel mathematics as a less interesting and difficult subject. I have been teaching mathematics at a secondary level for more than ten years. In my experience, I have found that more number of students fail in mathematics in almost all the examinations. Although most of the schools provide extra classes for mathematics, more number of students fail in this

subject. There could be various reasons behind this. As a teacher, I think the students have taken mathematics as a difficult subject due to the lack of better explore of mathematical concepts. Some students are not giving enough time for study and are not performing well in the examination whereas some other students devote enough time to mathematics, attend extra classes, yet are not performing well in the subject. Though the teachers claim that they try to make the students understand explaining by different ways, it seems that the students are not getting them properly. The students spend more time memorizing the algorithms and solutions. Research in England, Japan, China, and the United States supports the idea that mathematics instruction and student mathematics understanding will be more effective if manipulative materials are used (Schweyer, 2000, p. 4).

Now, I want to present my one of the experiences regarding the use of materials as effective tools of teaching and learning mathematics. First, I share my experience as a student and further as a mathematics teacher. I have started my formal education from Pashupati Boarding English School Jhapa, in the eastern village of Nepal. I studied in the school for three years at the primary level. After that, I got admitted in grade five in a government school. I studied in that school for four years. Then I joined another secondary school in another village in grade nine. I studied in the school for two years.

I do not remember much of the beginning of my formal education. As far as I remember, our teachers never taught us by using materials. In grade nine, I felt it difficult to understand geometry. My uncle advised me to take tuition classes with a teacher who was his former teacher. He taught us congruent triangles by using small bamboo branches. After that, he taught us theorems. I felt easy on solving problems related to congruent triangles, and I even started to prove some basic geometric

theorems. After that, I was encouraged to help my friends in geometry about which I had just started to feel comfortable while solving the problems. The tuition teacher was my schoolteacher, who did not use the materials in the classroom. This event has aroused a question. Why was he not using those bamboo sticks in the school while teaching congruent triangles? There were about seventy students in the class but we were only two in the tuition class. Now I felt that the large number of students might be a reason for not using materials in the class. There may be others reasons too. After SLC, I got admitted to Patan Multiple Collage in the science stream. I spent five years to complete my bachelor degree. In my experience over five years, our mathematics teachers never used materials in our classroom.

After that, I started to teach mathematics at the lower Secondary level in a private school in Lalitpur district. After a few months, I got a chance to participate in a Lower Secondary Level Mathematics Training conducted by Secondary Education Development Unit. There I learned to prepare some materials. After that, I started using them in the classroom. While I used materials, I felt that students felt more interesting and concentrated more towards me in the classroom.

After eight years of my teaching profession, I joined Kathmandu University for pursuing Master of Education in Mathematics. There I took a material development class and learned to prepare materials and to handle them. After that, I started teaching using materials. When I started teaching using materials, I found that students are more motivated towards study. I realized that they constructed the mathematical concepts on their own way and used the ideas to solve the problems. They started working together in solving problems. Learning theorists have suggested that children's concepts evolve through direct interaction with the environment, and materials provide a vehicle through which this can happen (Post, 1981). Using

materials, I found that some students who could not enjoy in abstract ideas connect to the mathematical ideas with the materials and develop the ideas themselves. I also felt that using materials, it can be taught in lesser time in comparison to teaching mathematics without using them.

The government as well as some private schools in our country are spending significant amount of money to train the teachers. In training, teachers learn to develop the materials and to use them in the classroom. But in my experience most of the teachers who are trained do not use the materials in their classrooms. Some of them use the materials occasionally. What are the reasons behind it? What perception do they hold about teaching materials? Why are they not using materials to make their teaching more effective? What are the challenges to use materials in their classrooms? This event encouraged me to do the research in this area.

Effective Use of Materials

Research studies in England, Japan, China, and the United States support the idea that mathematics instruction and student mathematics understanding will be more effective if manipulative materials are used (Heddens, 2007). To teach students with manipulative, it is very important for them to become familiar with the items and make observations. The teacher can model their use, but it is preferred to allow a student to work with a partner or in a group and then share their results on how they used the materials. Students learn best when they participate actively in the learning process. They assimilate knowledge when the opportunity is given to explore, investigate, question, describe, share, and talk about their discoveries. Some advantages of concrete materials are they are suitable for all age and ability levels; they promote student-centered learning, increase peer and tutor interactions. Using concrete materials in teaching mathematics will help students learn to relate real

world situations to mathematics symbolism, work together cooperatively in solving problems, discuss mathematical ideas and concepts, verbalize their mathematics thinking, solve problems without teacher direction, and learn that there are many different ways to solve problems. Manipulative use is a fun, easy way to introduce and visualize a concept. Problems are brought to life and students can build their confidence by giving them a way to assess and confirm their reasoning (Stix, 1992).

Manipulative materials in teaching mathematics will help students to understand mathematics. At the same time manipulatives harm if they are used poorly. Manipulatives that are improperly used will convince students that two mathematical worlds exist, one is manipulative and the next is symbolic. All mathematics comes from the real world. Mathematics in a book is a translation of real word situation into a symbolic form for calculation. For example, putting three goats with five goats to get eight goats is the real world situation but in mathematics, we say 3+5 = 8. These are not two different worlds but they are in the same world expressing the concepts in two different ways.

The manipulative materials should relate to the students' real world. For example, an abacus is not used in daily life. Instead stones, beans, pencils sticks, etc. would be more appropriate. Each student needs materials to manipulate independently. Demonstrations by the teacher or by one student are not sufficient. With students actively involved in manipulating materials, interest in mathematics will be aroused. Manipulative materials must be selected that are appropriate for the concept being developed and appropriate for the developmental level of the students. For example, one stick may be placed on a place value chart in the one’s place. However, one stick should not be placed in the ten’s place. Instead a package of ten sticks bundled together with a string or an elastic should be placed in the ten’s place.

Students need to realize and conceptualize the idea of tenness. The same is true for the concept of the hundred's place; a bundle of 100 identical things should be used. As the students' concept of place value develops, then single sticks can be used for place value of numbers with greater values.

Good mathematics manipulative materials are durable, simplistic (easily manipulated), attractive (to create interest), and manageable. A systematic method should be developed for storage and distribution of materials. Baskets or boxes are convenient for storage and distribution purposes. Using manipulative materials in teaching mathematics will help students learn:

1. to relate real world situations to mathematics symbolism.
2. to work together cooperatively in solving problems.
3. to discuss mathematical ideas and concepts.
4. to verbalize their mathematics thinking.
5. to make presentations in front of a large group.
6. that there are many different ways to solve problems.
7. that they can solve mathematics problems without just following teachers' directions.

If mathematics is taught using manipulative materials, then the methods of evaluating mathematical achievement must also change. Just calculating correct solutions to mathematics problems is not sufficient. Concept development and understandings should be valued more highly. Effective use of manipulatives helps to develop concept and to understand mathematical ideas (Hidden, 2007). Evaluation of students' mathematics should be changed from tests to assessment. For teachers to know students' understanding of concepts, different techniques of evaluation are needed. Teachers will receive more insight into students' mathematics understanding

by:

1. listening to students' talk about their mathematics thinking.
2. observing students working individually and in cooperative groups.
3. asking why and how questions rather than asking:
    a. yes or no questions.
    b. for results of calculating activities.
    c. for answers.
4. having students write a solution to a problem rather than by only responding with correct or incorrect values.

My Research Problem

In these days, most of the students feel mathematics as a less interesting and difficult subject. For school students, mathematics is a major headache. Many researchers have concluded that students' interest in mathematics can be aroused (that in turn increases their mathematical achievements) by using manipulative material. One of the best ways in which mathematical ideas may be developed or applied is through activities with physical materials or manipulatives (Schweyer, 2000). Long term use of concrete material is positively related to increase in student mathematics achievement and improved attitudes towards mathematics (Grouws & Cebulla, 2000 p.27).

Government as well as private schools are providing training for teachers to develop their teaching skills. They understand the importance of manipulatives in teaching mathematics. They learn to develop the manipulatives and to use them in the classroom. In practice for some days they use the materials but they do not use them for a long term. There may be different reasons for this. Use of materials in their instruction may be guided by their perceptions towards materials. Without finding the

reasons and solving the problem of not using manipulatives in their classroom, investing money as well as time in training teacher is in vain.

Effective use of manipulatives in mathematics instruction contributes to better conceptualization and understanding. Its use is a fun and easy way to introduce and visualize a concept. Problems are brought to real life and students can build their confidence by giving them a way to assess and confirm their reasoning. At the same time, manipulatives hold potential for harm if they are used poorly. For several years I have been teaching mathematics at the secondary level. While finding surface area of a solid formed by attaching two or more solids (cylinder, hemisphere and cone) having equal radii, some of students get confused to determine the existing (visible) surfaces of the solid formed by attaching two or more solids. They found the area of the visible as well as non visible (attached) surfaces of the solid. When I demonstrated the solid materials and asked them to observe then they were able to identify the visible surface of the solid formed by attaching two or more solids and they found the total surface area of the solid. I felt that I taught the chapter in less time making students understand by using solid materials. I also asked questions to mathematics teachers about the use of materials in their instruction. Most of the teachers told me that they use for some time and that they are beneficial only for primary level students but not for secondary level students. Its use consumes more time and the course cannot be completed on time. Some of the teachers told that they do not use it at all. Some of the teachers told its use is beneficial for all level students but they do not use. These responses of teachers and my experience of teaching using materials motivated me to find answers to the following questions. What perceptions do mathematics teachers hold on using materials in their instruction? In what way do mathematics

teachers use materials in their instruction? How do teachers explain challenges and benefits of using materials in mathematics classroom?

Research Questions

I have understood that research questions are the keys of research and they are the pulling substances of the research. A researcher always tries to run according to the research questions to get the direction and possible solutions to the research problems. Thus, I set the following research questions to get the answers in my research.

1. What perceptions do mathematics teachers hold towards materials?
2. How do mathematics teachers use teaching learning materials in their classes?
3. How do mathematics teachers explain challenges and benefits of using materials in their instruction?

Rationale of the Study

Mathematics teaching without using manipulatives is not meaningful. These are one way of making mathematics learning more meaningful to students (Stein & Bovalino, 2001), as "they are materials designed to represent explicitly and concretely mathematical ideas that are abstract" (Moyer, 2001, p. 176). “Using manipulative textbook problems are brought to life and students can build their confidence by giving them a way to assess and confirm their reasoning” (Stix, 1992). Teachers are the persons who directly interact with the students. They are the persons to implement teaching policies, strategies and techniques in a classroom. Implementation of teaching strategies and techniques is guided by the philosophies. Use of materials in their instruction is guided by their perceptions about their use, benefits and challenges. This study is to find the perceptions and practices of mathematics teachers towards materials in their instruction. Further it explores the challenges and benefits

of using materials in mathematics instruction in the view of mathematics teacher. The findings of this study may be helpful to know the perceptions and practices of mathematics teachers towards materials in their instruction and to explore the challenges and benefits of using materials in their instruction. The findings may be significantly beneficial to educational policy makers, syllabus designers, textbook writers, and those who are directly or indirectly involved in the education sector. Those who come across this dissertation will know a lot about using manipulatives in the classroom. More specifically, it will be useful to all the mathematics teachers.

Delimitations of the study

In this study, I focused on exploring perceptions and practices of mathematics teachers towards the use of materials in their instruction. Furthermore, I tried to explore challenges and benefits of their use. In this study, I did not try to find the reasons of their practice. Due to time constraints and lack of resources, the study was limited in Kathmandu Valley. Participants were from different secondary level schools of Kathmandu valley. In this study, I focused only on concrete materials. The findings of the study were based on interview with the research participants and observation of two classes of each participant.

Chapter Summary

In this chapter I have tried to present my past and present experiences as a student and as a teacher about the positive role of materials to enhance conceptual understanding of mathematical ideas through which the research problem arouse. Further, I tried to present the research problem, the questions which seek the answer to address the research problem, rationale of the study and the delimitations of the study.

CHAPTER II

LITERATURE REVIEW

Chapter Overview

Literature review is one of the essential aspects of my research. Literature review in a research study provides the readers with ideas about the results of other studies that are closely related to the study being reported. Cooper (1998, as cited in Creswell, 2003, p. 210) suggests that literature review relates a study to the larger ongoing dialogue in the literature about a topic, filling in gaps and extending prior studies. It discusses published information in a particular subject's area and sometimes information in a particular subject's area within a certain time period. It provides us with a handy guide to a particular topic.

This section deals with the relevant literature related to the use of materials in mathematics teaching. It discusses the various studies carried out by the various scholars including ongoing dialogues relating to the use of materials in mathematics teaching. The main objective of literature review is to gain familiarity with the subject matter to get enough knowledge to develop conceptual framework, validity of the concept and to adopt appropriate research methods.

History of Manipulative Materials

Since ancient times, people of several different civilizations have used physical objects to help them solve everyday math problems. The ancient civilizations of Southwest Asia used counting boards, which were wooden or clay trays covered in a thin layer of sand. The counting board users would draw symbols in the sand to tally

inventory or whatever else they may need to count. The ancient Romans created the first abacus based on counting board. The abacus was made of beans or stones which moved in groove in sand or on tables of wood, stone, or metal. “The Chinese abacus, which came into use centuries later, may have been an adaptation of the Roman abacus” (Boggan et al., n.d.).

The Mayans and the Aztecs both had counting devices that were made of corn kernels strung on string or wires that were stretched across a wooden frame. “The late 1800s saw the invention of the first true manipulative objects that appeal to several different senses and are specifically designed for teaching mathematical concepts” (Boggan et al.,n.d.). In 1837, German educator Friedrich Froebel introduced the world’s first kindergarten. He designed the educational play materials known as “Froebel Gifts, or *Frobelgaben,* which included geometric building blocks and pattern activity blocks” (Boggan et al.). Then in the early 1900s, Italian educator Maria Montessori continued with the idea that manipulatives are important to education. She designed several materials to help elementary students learn the basic ideas of math. In developing Montessori’s method of sensory education, she created objects called “didactic materials” that represent abstract concepts and help students learn from their senses (Zuckerman, 2006, as cited in Johana, 2009). These materials were for learners with the purpose of having students learning from their experiences according to their developmental stage. She paid special attention to the environment and how it provides learning opportunities for children. In this kind of environment, students are free to learn and teachers’ main work is to observe students and address them in their thinking processes (Johana, 2009). “Since the 1900s, manipulatives have come to be considered essential in teaching mathematics at the elementary school level” (Boggan et al., n.d.).

Manipulative Defined by Teachers and Researchers

In this section, I discuss the interpretation of the term manipulative by different teachers and researchers found in the journey of literature review. Sherman and Richardson (1995), studying 25 elementary school teachers state that teachers have different interpretations of the term *manipulatives*. For some teachers, manipulatives are any concrete materials students can touch (such as boxes, calculators, chalkboard etc.), while for other teachers, manipulatives are tools such as geoboards, strips of papers, or rulers.

Not only teachers have varied definition of the term *manipulatives*, researchers in mathematics education also differ on their definition. When they refer to manipulatives their definitions may describe concrete manipulatives, computer base/virtual manipulatives, or any kind of manipulatives. Definitions of manipulatives, specifically concrete manipulatives, found in the literature are not equivalent and are sometimes even contradictory. For example, Yeatts (1997) expresses that "manipulative materials are objects or things that appeal to several of the senses" (p. 7). According to this definition, a video is a manipulative because it appeals to visual and audio senses. For other researchers or educators, manipulatives are objects that can be touched, moved around, rearranged, or stacked. In this case, books in a shelf are considered manipulatives because they can be organized though they may just be used to read or solve problem sets.

Moyer (2001) states that manipulatives are "objects designed to represent explicitly and concretely mathematical ideas that are abstract. They have both visual and tactile appeal and can be manipulated by learners through hands-on experiences" (p. 176). In this case, manipulatives are just commercial objects, such as cylinder, sphere, pattern blocks, or computer base/virtual manipulatives. Strings or rubber

bands used in activities to help students understand a mathematical concept are not manipulatives because they are not designed for that purpose. In this definition, Moyer (2001) also refers specifically to two senses: tactile and visual instead of *several* senses as referred to in Yeatts (1997). Some definitions propose learners as users of these tools, for instance, Durmus and Karakirik (2006) state that manipulatives are models of mathematical concepts that can be manipulated by students and appeal to their senses. However, Heddens' (2005) definition states students have to have the opportunity to use the objects and they should not be objects just for teacher demonstration. McNeil and Jarvin (2007) define that manipulatives are objects that help students learn or understand mathematics. Uttal et al. (1987) state that these objects are designed specifically to help students learn mathematics, but McNeil and Jarvin (2007) define them as any object that helps students understand mathematics, even if these objects were not designed for that purpose. Textbooks can be manipulatives because they help students learn, so too can pencils, whiteboards, computers, calculators and notebooks be considered manipulatives according to these definitions- even if students just use these objects to read, write symbols, draw pictures, or make calculations.

As a conclusion, the term *manipulatives* is generally used in different ways among teachers as well as among mathematics educators. For some, manipulatives are any concrete object including objects such as chalkboard, rulers, calculators, papers, or geoboards. Definitions of manipulatives involve different aspects such as their need to appeal to senses (Yeatts, 1997; Moyer, 2001) that represent mathematical concepts (Durmus & Karakirik, 2006; Moyer, 2001), how students use them (Heddens, 2005), or reasons for using these tools (McNeil & Jarvin, 2007).

All these definitions show vast differences in what people, in general, mean when they describe these tools. However, from the previous discussion, a definition can be comprised that encompasses the main characteristics identified for these devices. Objects can be called *manipulatives when* they are used (stacked, moved around, arranged, etc) by students and/or teachers to represent mathematical ideas/concepts/relations. It is by the senses, mainly visual and tactile, that manipulative users can perceive the mathematical representations. To be called manipulatives, the objects should be manipulated and not just be displaying computations or graphics. Therefore, any object can be used as a manipulative, although an object *is not* necessarily always used as a manipulative.

Teachers' Beliefs and Manipulative Use

In this section I discuss the beliefs of teachers towards materials which relate to the teachers' reason to use the manipulatives in their instruction that I have found in literature review as Mayor (2007) states Information regarding teachers' beliefs about manipulative use relates to teachers' reasons for using these tools in the classroom. Most of the mathematics teachers believe that manipulatives should be used in mathematics classroom as Suidam (1984) reports the result of his questionnaire that "most teachers indicate that they believe that manipulative materials should be used for mathematics instruction" (p. 27). She does not, however, explain or present reasons that teachers have for using these tools in their classroom.

Some mathematics teachers believe that manipulative materials are the tools to be used in mathematics classroom which help students to learn mathematics with understanding whereas some mathematics teachers believe that these tools help students to motivate and some teachers believe these tools serve as a reward for students (Moyer, 2001). Howard et.al (1997), studying survey answers from 939

teachers of different levels (603 primary and 336 secondary), compared manipulative use between primary and secondary teachers. They found that a majority of the teachers (94% primary teachers and 84% secondary teachers) report that these tools are beneficial for students' learning process. However, the benefits of using these devices are not explained in the document. Additional reasons indicated by teachers include school mathematics policy (15% primary teachers and 8% secondary teachers) and syllabus mandate (10% primary teachers and 4% secondary teachers) but these reasons seem to have less influence on teachers' decision to use manipulatives in their classrooms. It is not clear if the teachers in this study chose many of these options or if they wrote reasons on their own (open-ended question). If teachers have chose, from a set of given options, their expression of reasons may be limited. Teachers may have other more important reasons for why and how teachers use these tools in their classrooms (Johana, 2009, p. 39).

Sherman and Richardson (1995) found that 76% (19 of 25 teachers) of their participants report using manipulatives and they summarize teachers' reasons for using these tools. The most common reason (31% or 6 of the 19 teachers using manipulatives) was that students using manipulatives have opportunities to learn "via senses of touch and sight providing student a strong foundation for understanding a concept" (p. 30). The second most common reason (26% or 5 of the 19 teachers) was the concrete manipulative property; teachers identify that mathematical concepts can be perceived in a concrete way when using manipulatives. Improvement in students' conceptual understanding was reported as a reason for 2 of the 19 teachers (11%). However, as Sherman and Richardson (1995) express, how manipulatives actually help to improve understanding was not specified by the teachers. The reasons given by teachers in this study are similar to what Howard, Perry and Tracey (1997) found

as the most common reason: benefit to students' learning process. Sherman and Richardson (1995) provide more information about how teachers see manipulative use help students' learning processes. The reasons for manipulative use reported in Sherman and Richardson (1995) were: (1) by using several senses (2) to help give concreteness to abstract concepts and (3) conceptual understanding. Even though these three reasons could be together when teachers explain their reasons of using manipulatives in their classrooms, separating them gives us more information about teachers understanding of manipulatives. For example, a teacher reported that through using these tools, students "can see and feel concepts" (Sherman & Richardson, 1995, p. 30) and that manipulatives allow students to see and feel concepts in a concrete way. These tools help to introduce what is abstract in mathematics as well as increase students' understanding. However, these teachers may value the use of senses in learning more than the fact that manipulatives give a concrete representation of mathematical concepts or increase students' understanding. McNeil and Jarvin (2007) have been presenting more ideas to support the use of manipulatives in mathematics classrooms. McNeil and Jarvin (2007) present three of them: manipulatives provide additional resources, manipulatives help to connect mathematics with real-world experiences, and manipulatives help memory and understanding because of the physical movements required while using these tools.

Many other reasons motivate manipulative use in mathematics classrooms. "One is the trend toward students' involvement in mathematics instruction because students are "active" when they work with these tools" (Suydam, 1984). Motivation is another reason to support manipulative use in mathematics classes because lessons including manipulatives are fun and engage students in class activities that involve work with these tools (Moyer, 2001). Moyer (2001) studied how 10 teachers used

manipulatives in their classroom and found that some of these teachers used manipulatives with the purpose of giving students enjoyment and fun. After analyzing data from teachers' interviews, Moyer (2001) found that teachers refer to manipulative use as play time or reinforcement time which they differentiate from "real math" (p. 185) where "they taught rules, procedures and algorithms using textbooks, notebooks, worksheets, and paper and pencil tasks" (p.185). She states that because students seem to like activities involving manipulative use, teachers use those activities as rewards for students' behavior (Moyer, 2001) instead of as active tools in helping them to learn mathematical concepts.

Teachers may want to use manipulatives if they are looking for ways to involve students in mathematics classes (Suydam, 1984), make mathematics lessons more enjoyable (Moyer, 2001), and/or help students learn mathematics (McNeil & Jarvin, 2007). However, the way to use these tools in order to accomplish those objectives is not clearly established in the literature. Teachers may assume that just because they use these tools, their lessons are enhanced, successful and entertaining.

Many teachers view manipulatives as play objects, suitable only for younger children and, thus, have no validity for implementation in higher-level mathematics. In addition, some teachers use manipulatives as rewards for appropriate student behavior. "Teachers who view manipulatives as time wasting or secondary to the serious work of learning mathematics will inadvertently encourage their students to use these materials for play, rather than for mathematical learning or understanding" (Moyer & Jones, 2004, p. 29). Following their yearlong study of 10 middle grades teachers' use of manipulatives, Moyer and Jones found that manipulative use was more diversionary than instructional. Using interviews, observations, and self-report, they investigated how teachers used manipulatives in typical classroom setting.

Teachers used them for problem solving and enrichment, a change of pace, "fun," and for providing a visual model for concept introduction, but they did not see how they could be used to teach state curriculum objectives as efficiently as paper and pencil approaches.

Manipulative Use and Student's Performance

In this section, I discuss results from different studies that attempt to evaluate the relationship between manipulative use and student performance. The effectiveness of manipulative use has most often been measured through achievement scores on tests and tasks. The effectiveness of manipulative use has been studied using several different research designs, such as pretest-posttest with control group design. Some researchers have found a positive relationship between manipulative use and student achievement others have found partial positive results, no differences between groups of students using and not using manipulative or even lower results in manipulative user's groups.

Suydam and Higgins (1977) also analyzed results from 23 studies that compared groups of students using manipulatives and groups not using these tools. In 11 studies, students using manipulatives scored significantly higher than the non-manipulative group of students; in 10 studies there was no significant difference between the groups and in two studies the students not using manipulatives scored higher. However, other studies using the same design have found lower performance by the treatment group. McClung (1998) compared two classes of high school students enrolled in an Algebra I course. The treatment group used Algeblocks while the control group used worksheets for practice. In this study, both groups worked for nine weeks in cooperative learning groups and the teaching method was similar. For the control group, the teaching strategy was lecture, homework and in class work

sheets (p. 27). For the treatment group worksheets were replaced with manipulatives. Student achievement was assessed before and after treatment using a test constructed by the teacher. McClung found that the control group scored significantly higher than the treatment group. According to the author, two possible factors affecting the lower results of the manipulative group of students were the teachers' lack of knowledge about using these tools in their classroom as well as students' lack of familiarization with the devices. It may also be the case that the manipulatives were not used to help build concepts, but only for practicing what was taught by traditional lecture instruction.

The majority of the studies found in the literature examine the relationship between students' mathematics performance and manipulative use using pretest-posttest designs. In one study, Posadas (2004) included multiple measures of achievement during the treatment period, in other words, she used a repeated measures control design. In this study, Posadas (2004), aimed to examine if manipulative use and visual cues help mathematics learning. Sixty-four Hispanic students who failed four of the mathematics objectives of the Texas Assessment of Academic Skills (TAAS) participated in this study. The objectives assessed were: "use of the operation of multiplication to solve problems", "use of the operation of division to solve problems", "estimate solution to a problem situation", and "determine solution strategies and analyze or solve problems" (p. 49). One day per week for 5 weeks, students worked on a specific objective. During instruction, students in the treatment groups used either manipulatives or visual cues. Participants' performance was measured 6 times during the 5 weeks of treatment, once before treatment and once every week of treatment. Posadas found no significant difference between the treatment groups and the control group performances. One possible

reason for these results, as stated by Posadas, was the short period of time that students were given to use the tools.

Other studies have used pretest-posttest without control group designs to measure the success of manipulative use. Among these studies, some found significant improvement in students' scores when they used manipulatives during learning activities. Trespalacios (2008) compared two generative instructional strategies, answering questions and generating examples using virtual manipulatives to teach fractions to third grade students during one day. In this repeated measures study, students' knowledge of fractions was tested once before the treatment and twice after. He found that students' scores, in both groups, increased significantly after treatment and were maintained two weeks after the instruction.

In another study, Suh and Moyer (2007) studied differences in the impact of two types of manipulatives, physical and virtual, on students' achievement in algebra. According to the authors in both groups, teachers first introduced the manipulatives to their students. Then, students in the physical manipulative group completed algebraic equations on a worksheet prepared by the teacher. Students in the virtual manipulative group completed algebraic equations created by computer software. They found that both groups of students achieved higher scores on their posttest after one week of using the manipulatives. However, without a control group it was difficult to attribute learning solely to manipulative use.

Yet, not all the studies using pretest-posttest without control group designs have found positive relationships between manipulative use and student performance. In a study by Remier and Moyer (2005), the teacher gave students the opportunity to manipulate virtual base ten blocks applets before the treatment. This was done to provide students with experience manipulating similar applets to those that were

going to be used in the study. During treatment, the teacher introduced students to an applet for working with fractions. On a worksheet, the teacher provided instructions for the applet and the exercises to be solved using the virtual manipulatives. All materials were designed by the teacher. Reimer and Moyer found students' conceptual knowledge scores increased significantly after the treatment, but students' procedural knowledge scores did not.

Suydam and Higgins (1976) state "lessons involving manipulative materials produce greater mathematical achievement than lessons in which manipulative materials are not used if the manipulative materials are used well" (p. 92). The following suggestions were made by Suydam and Higgins (pp. 92-94):
1.Manipulative materials should be used frequently in a total mathematics program in a way consistent with the goals of the program. 2. Manipulative materials should be used in conjunction with other aids, including pictures, diagrams, textbooks, films, and similar materials. 3. Manipulative materials should be used in ways appropriate to mathematics content, and mathematics content should be adjusted to capitalize on manipulative approaches. 4. Manipulative materials should be used in conjunction with exploratory and inductive approaches. 5. The simplest possible materials should be employed.

A study by a group of students Ebele, Okibgo, Abigail, and Osuafor (2008) on "Effect of using materials in teaching mathematics on the achievement of mathematics students" has made a conclusion that students taught using materials achieved better than those taught without it and there exist no significant difference in achievement of male and female mathematics students taught using materials. Researchers have made the recommendations that teachers should use the materials in

teaching mathematics. Seminars/workshops should be organized for mathematics teachers on the use of materials in mathematics classroom.

A study of Shrestha (1991) on “Use of instructional materials in class room teaching of trained and untrained teachers” has concluded that 1.Trained teachers are more efficient than untrained teachers in using materials 2. Trained teachers use materials more appropriately and usefully than untrained teachers 3.Some trained teachers do not use the materials. Therefore he concluded that teacher training had positively influenced the teachers in preparation and use of instructional materials in class.

Theoretical Review

Dienes's Theory of Mathematics Learning

Dienes's theory of mathematics learning has three basic components or principles.

The Dynamic Principle. This principle suggests that true understanding of a new concept is an evolutionary process involving the learner in three temporally ordered stages. The first stage is the preliminary or play stage, and it involves the learner with the concept in a relatively unstructured but not random manner. For example, when children are exposed to a new type of manipulative material, they characteristically 'play' with their newfound 'toy.' Dienes suggests that such informal activity is a natural and important part of the learning process and should therefore be provided for by the classroom teacher. Following the informal exposure afforded by the play stage, more structured activities are appropriate, and this is the second stage. In this stage child is given experiences that are structurally similar to the concepts to be learned. The third stage is characterized by the emergence of the mathematical concept.

The Perceptual Variability Principle. This principle suggests that conceptual learning is maximized when children are exposed to a concept through a variety of physical contexts or embodiment. The experiences provided should differ in outward appearance while retaining the same basic conceptual structure. The provision of multiple experiences (not the same experience many times), using a variety of materials, is designed to promote abstraction of the mathematical concept. When a child is given opportunities to see a concept in different ways and under different conditions, he or she is more likely to perceive that concept irrespective of its concrete embodiment. For example, the regrouping procedures used in the process of adding two numbers is independent of the type of materials used.

The Mathematical Variability Principle. This principle suggests that the generalization of a mathematical concept is enhanced when the concept is perceived under conditions wherein variables irrelevant to that concept are systematically varied while keeping the relevant variables constant. For example, if one is interested in promoting an understanding of the parallelogram, this principle suggests that it is desirable to vary as many of the irrelevant attributes as possible. In this example, the size of angles, the length of sides, the position on the paper should be varied while keeping the relevant attribute-opposite sides parallel. Dienes suggests that the two variability principles be used in concert with one another since they are designed to promote the complementary processes of abstraction and generalization, both of which are crucial aspects of conceptual development.

The unifying theme of these principles is that of stressing the importance of learning mathematics by means of direct interaction with the environment. Dienes is continually implying that mathematics learning is not a spectator sport and, as such, requires a very active type of physical and mental involvement on the part of the

learner. In my experience manipulative materials help students in such type of involvement.

Lesh (1979, as cited Post, 1981) has suggested that manipulative materials can be effectively used as an intermediary between the real world and the mathematical world. He argues that such use would tend to promote problem-solving ability by providing a vehicle through which children can model real-world situations. The use of manipulative materials (concrete models) in this manner is thought to be more abstract than the actual situation and less abstract than symbols.

Chapter Summary

In this chapter I tried to present the findings of different researchers on the topic similar to my research that I have reviewed. I tried to present the history of manipulative materials, interpretation of the term manipulative by different teachers and researchers, teachers' beliefs and manipulative use, manipulative use and students' performance. Furthermore I presented Denies' theory of mathematic learning as the theory of my research study.

CHAPTER III

RESEARCH METHODOLOGY

Chapter Overview

This chapter deals with the method I have adopted to conduct this study. In this chapter I have tried to include the reason to adopt the method that I followed in the research journey. This chapter includes my ontology, epistemology and axiology. Further, this chapter includes the method and reason of selecting research site and participants. It also includes the data collection tools, data collection procedure and procedure of data analysis and interpretation.

Qualitative Research

Qualitative research data refer to the opinions and feelings of the real world obtained from the face to face and in-depth interview of the participants. The more feelings of an individual are appreciated in the qualitative research. The qualitative aspect of the research problem is emphasized more than the quantitative aspect in the qualitative research. While studying a social problem it is a method in which stress is laid on quality rather than on quantity aspects.

Denzin and Lincoln (2005) say that the qualitative research is a situated activity that locates the observer in the world. It consists of a set of interpretative, material practices that make the world visible. These practices are transformative in the world. They turn the world into series of representations including field notes, interviews, conversations, photographs recordings and memos to the self (p. 3).

It includes the society constructed nature of reality, the intimate relationship between the researcher and what is studied, and the situation constrains the shape of inquiry. It is a set of interpretive activities, privileges and no single methodological practice over another. Quoting Denzin and Lincoln (2005), I found qualitative research emphasizing many areas which Richards (2003) also says that qualitative research is multimedia in focus, involving an interpretative, naturalistic approach to its subject matter.

For Creswell (2003), qualitative researches embrace any kinds of approaches like ethnographies, grounded theory, case studies, phenomenological research and narrative research (p.18). Denzin and Lincoln (2005) say that qualitative research can have different forms and they are observation, participation and interviewing and ethnography etc. Data for qualitative research is different to that of quantitative research since qualitative research not only emphasizes cardinal number but demands open ended, emerging data with the primary intent of developing themes from the data. I collected open ended data and personal experiences of teachers. in this regard, Denzin and Lincoln (2005) say, "Qualitative research involves the study, use and collection of a variety of empirical materials-case study; personal experience; introspection; life story; interview; artifacts; cultural texts- that describe routine and problematic moments and meanings in individuals lives" (p.3-4).

Anderson (1998) defines "qualitative research is a form of inquiry that explores phenomenon in their natural settings and uses multi-methods to interpret, understand, explain and bring meaning to them" (p.119). Qualitative researcher aims to gather an in-depth understanding of human behavior and the reasons that govern such behavior. Flick (2006) says, "The essential features of qualitative research are the correct choice of appropriate methods and theories; the reorganization and

analysis of different perspectives; the researchers' reflections on their research as part of the process of knowledge production; and the variety of approaches and methods" (p.14).

Ontology

Ontology is a branch of philosophy which is concerned with the theory of reality and the existence. Cohen, L. Manion, L. & Morrison,K. (2008) state that ontological assumption concerns the very nature of essence of the social phenomena being investigated (p. 7). Similarly Willis (2007) says, "Ontology is concerned with the nature of reality and various ontological positions reflect different prescriptions of what can be real and what cannot be" (p. 9). There are various types of ontological positions. The position of physical or material world believes that reality is the physical world and the position of idealism purposes that the reality is mental and spiritual. Another position of ontology is metaphysical subjectivism that asserts perception, what we perceive through our senses creates reality. I tried to explore inter-subjective reality in my research. I believe that all individuals are different and they have different perceptions, belief systems and socio cultural understandings. My research participants were encouraged to construct their realities in their own way in the process of interview. Then I interpreted them through my perceptions and progressively improved subjectivities. My research participants were free to generate and interpret their reality according to their context. I played the role of questioner with the metaphor of what the popular spiritual-philosopher Krishnamurti says of questioner as a seeker of meanings.

Epistemology

Epistemology is a branch of philosophy which is concerned with ways of knowing. Burrell and Morgan (as cited in Cohen et al., 2007) say that "epistemology

concerns the very bases of knowledge, its nature and forms, how it can be acquired and communicated to other human beings" (p. 7). In my research, I generated knowledge on the basis of my participants' understanding i.e. responses to research questions and observation of their activities. Participants generated the knowledge on the research issue through their self reflection and interactions. In this regard, Cohen et al. (2007) say that in interpretive tradition, an understanding of the way in which the individual creates, modifies and interprets the world in which he or she finds himself or herself. I interpreted each participant's understanding regarding perception of mathematics teachers towards materials and challenges and benefits of using materials in their instruction.

Axiology

Axiology is a theory of value. Cohen et al. (2007) say, "Axiology concerns with human nature and, in particular, the relationship between human beings and their environment" (p. 8). They argue that there are two types of images of human nature, "one is determinism which gives the meaning controlled environment and voluntarism gives the meanings that free will and creativity" (Burrell & Morgan, as cited in Cohen et al. 2007, p. 8). In my research, all individuals have their own values. They are different in nature and they have their own environment for learning and existing. So, participants' perceptions and values were given more importance in my research.

The Interpretive Paradigm

By the use of interpretive paradigm, the researcher understands other cultures and interprets from the inside. Interpretive knowledge of other is produced through a prolonged process of interaction undertaken by ethnographer who immersed themselves within the culture they are studying (Tayler et al., 2011). I tried to understand mathematics teachers' perceptions and practices establishing ethically

sound relationship and hence interacting with them and observing their practice. Using ethnographic method of informal interviewing, participant observation and establishing ethically sound relationship; interpretive researchers construct trustworthy and authentic account of the other (Tayler et al., 2011). While conducting interview, I asked mostly open ended questions so that the participants would get enough place to express their views. During interpretation of the data, I was very conscious about my subjectivity so that my past and present values and beliefs did not influence the interpretation of thought, feeling and the practice of the other.

Selection of the Research Sites

I chose Kathmandu valley as the research site for my study. The reason to choose this site is that I am staying and working in Kathmandu and I can easily find the participants according to need of my research problem and I can easily reach to the participants. The nature of my research is interpretive in which I tried to include thick description of the information taken from participants. I felt there may be different educational environment, in government and private schools. So I selected two participants from government schools and four from private schools.

Selection of Research Participants

To bring in-depth information within a certain period, I selected six participants from six different schools to know their perceptions and practices regarding the use of materials in mathematics instruction. Out of six selected schools, three schools were from Lalitpur district, two were from Bhaktapur district and one from Kathmandu district. All the participants are the secondary level mathematics teachers. I selected only one female participant as I realized there were very less female mathematics teachers at the secondary level (Thapa Magar, 2012). Out of six participants four were from education and two were from non education (pure

mathematics) background in their studies. I used the symbols T_1, T_2, T_3, T_4, T_5 and T_6 to denote the participants. The following are the short descriptions about the participants.

T_1 is a male, secondary level mathematics teacher. He is working in a private school in Lalitpur district. He has more than 10 years of experience in mathematics teaching in different schools. He has done Master of Education in mathematics.

T_2 is a male, secondary level mathematics teacher. He is working in private school in Lalitpur district. He has 8 years of experience in mathematics teaching. He has done Master of Education in Mathematics.

T_3 is a male, secondary level mathematics teacher. He is working in a Private school in Bhaktapur district. He has 12 years of experience in mathematics teaching in different schools. He has passed MEd in mathematics. He has also published text books and practice books of mathematics for the secondary level.

T_4 is a male, secondary level mathematics teacher. He is working in a government school in Lalitpur district. He has almost 6 years of experience in mathematics teaching in different schools. He is an MEd in mathematics.

T_5 is a male, secondary level mathematics teacher. He is working in a Private school in Bhaktapur district. He has 4 years of experience in mathematics teaching in different schools. He has passed Bachelor in Science. He has not taken any training or academic courses related to teaching.

T_6 is a female, secondary level mathematics teacher. She is working in a government school in kathmandu district. She has almost 7 years of experience in mathematics teaching at the secondary level. She has passed Bachelor in Mathematics. She has attended some training related to teaching mathematics but has not taken any academic courses related to teaching.

Data Collection Technique

I used interview and observation to collect the data for any research work. I used only primary data. Participants are the source of data in this research. I used the following techniques to collect the data in my research study.

Interview

Interview was my one of the data collection techniques. “Interview is the process of interchanging view with one another. It is a flexible tool for data collection, enabling multi-sensory channels to be used; verbal, non-verbal, spoken and heard” (Cohen et al., 2008, p. 349). Interviews are used to gather information regarding an individual’s experiences and knowledge; his or her opinions, beliefs and feelings; and demographic data (Best & Khan, 2007, p. 267). The purpose of interviewing is to find out what is in or on someone’s mind but to access the perspective of the person being interviewed (Pattron as cited in Best & Khan, p. 265). In an interview, knowledge is created in between the point of view of the interviewer and the interviewee (Kvale, 1996, p. 124). Further, Kavle (1996) says, “The qualitative interview is a uniquely sensitive and powerful method for capturing the experiences and lived meaning of the subjects’ everyday world” (p. 70). I used both unstructured and semi structured interview. “Unstructured interviewing tends to be very similar in character to a conversation” (Burgess, as cited as in Bryman, 2008, p. 438) and “in semi-structured interview, the researcher has a list of questions or fairly specific topics to be covered, often reflected to as an interview guide, but the interviewee has a great deal of leeway in how to reply” (Bryman, 2008, p. 438).

In my research, I used just a few interview guidelines but mostly, interview was in the conversation form as it was unstructured. Semi structured and unstructured interviewing can be referred to collectively as in-depth interviews or qualitative

interviews" (Bryman, 2008, p. 438). I used both semi-structured and unstructured interviews with some interview guidelines as Best and Kahn (2007) states that the purpose of open-ended interviewing is to find out what is in or on someone else's mind, not to put things in someone's mind (p. 225). I learned many more things from the participants' experiences regarding my research problems. While interviewing, I was very conscious so that the data would not be biased and misled as Best and Kahn (2007)state "interview data can easily be biased and misled if the person being interviewed is aware of the perspective of the interviewer" (p. 266). Taking interview with the participants, I realized that unstructured interview or conversation type interview is more effective to establish friendly environment with the participants and it is easy to generate the knowledge regarding related study. Participants feel comfortable to express their experiences, views and ideas in such friendly environment. I also believe that semi-structured interview provides right direction to the interviewer.

I spent almost one hour with each participant. All the conversations of the interviews were recorded in a voice recorder. Later the recorded voice was transcribed. Analyzing the transcribed data of the first two interviewee, I felt the information were not enough to answer my research question. So I again went to them to take a second round of interview with revised questions. The recorded information was transcribed. I felt this data saturate the answer to my research question. Then with the help of the revised questions, I collected data from the remaining participants. But later I felt the data were still insufficient and I took data from some participants using telephone.

Observation

Observation was another technique of my data collection. I observed two classes of each participant. The purpose of the observation was to observe participants' practice on materials in classroom. During observation I was concentrated on observing the use of materials in their instruction, methods of using materials, types of materials used and storage of the materials. I entered into the class with the participants. I introduce myself with the participants and described the purpose of the observation. Observing participants' practice in classroom I sat at the last bench of the class and observed participants practice of materials. During observation of the class, I did not raise any question for students and teachers.

Data Collection Procedure

In this study, my aim was to know the perceptions and practices of mathematics teachers towards the use of material. So to know their perceptions and practices, I needed to interact with them as well as I needed to observe their classes. Therefore, I used interview and observation techniques to collect data. I used semi-structured and unstructured questions to guide my interview as Bryman (2008) states semi structured and unstructured interviewing can be referred to collectively as in-depth interviews or qualitative interviews (p. 438). Most of the participants were familiar with me. So, I did not feel any difficulties to manage time for interview. I telephoned them and fixed time one day earlier. I went to their schools with interview guidelines and a voice recorder. I met the principal or other administrative personnel and talked about the purpose of my visit to the school. After that I started to take interview with the participants. While interviewing, I was very conscious so that the data would not be biased.

One of the participants (female) was unknown to me. I got her phone number from a friend and contacted her. I informed her about my research and fixed time for the interview. At the time I went to her school and took interview with her. I transcribed the interviewed data. Observing the transcribed data of first two participants, I felt the data were not sufficient and rich to address my research questions. So I revised my interview guidelines and again went to them. I used the revised interview guidelines for other participants. At the time of interview, I informed them about their class observation and fixed the time. At the fixed time, I observed their classes. At that time, I fixed the time for the next observation too. I transcribed all the recorded data and thematized them for the interpretation purpose.

Data Analysis and Interpretation

Data are the main parts of my research study. I came to know that presenting data in the right way according to the demand of research questions is a challenging job. Creswell (2003) says, "Data analysis is an ongoing process involving continual reflection about the data, asking analytic questions and writing memos throughout the study" (p. 190). I collected all the data from the field through in-depth interviews and observation of the participants and then I transcribed them. After transcription, I went through the data to find the common ideas or views of the participants to organize them together. Then further, I tried to themetize the ideas under different headings. According to my research questions, I made some possible themes from my data which I have mentioned in chapter four, five and six. On the basis of these themes, I analyzed the data in detail with the help of the literatures. I did not use either real or fictitious names for the participants. I used the symbols T_1, T_2, T_3, T_4, T_5 and T_6 to denote to the participants. I found the possible answers to my research questions from the themes.

Quality Standards

Quality standards are required to maintain the trustworthiness and to enhance quality in a research. Conventionally, a researcher needs to include internal validity, reliability and objectivity to maintain trustworthiness of a research. These terms are approximately close to positivist research paradigm whereas I used interpretive research paradigm (Guba & Lincoln, 1989). So, to maintain the trustworthiness in my research, I heard participants' voices and I established myself deeply immersed in the research field. I tried to find out the actual data by conducting a series of interviews regarding the same theme. Until I got the saturation of my research theme I tried to bring out the ideas of the participants staying with them and interacting on the topic. To maintain trustworthiness in my research, the following concerns were used.

Credibility

Credibility is the criteria which talks about the idea of isomorphism between constructed realities of participants and those realities as represented by the researcher. There are several techniques for increasing the probability of such an isomorphism like; prolonged immersion in the field, checking interpretation with informants , engage in open ended or emergent inquiry (Taylor et al., 2011). To establish credibility in my research, mostly I used open ended questions in the interview. I spent more time with the research participants to establish good rapport with the participants and I shared the interpretation of the interview data to know whether they represent their perspectives or not. From the series of interviews with the participants I got the answers to my research questions. Until I reached the saturation point of my research questions, I tried to get more information from the participants (Guba & Lincoln, 1989).

Transferability

In my research, transferability represents the degree of similarity between researcher (sender) and readers' (receiver) context. To establish the transferability, I included thick description of what participants said during the interview and what I found during their class observation. All the participants of my research were mathematics teachers having long experience of teaching mathematics. They have different experiences, beliefs and practices about the use of materials in mathematics classroom. I tried to quote their words directly. I tried to present their perceptions and practices honestly. This shows that participants' experiences and views are more important to construct the transferability in this research study. I also tried to engage myself to interact with the participant to bring out the real data in my research (Guba & Lincoln, 1989).

Authenticity

The authenticity criteria focus on the ethics of the relationship established by the researcher with his/her participants (Taylor et al., 2011). Authenticity talks about fairness and beneficence. My research participants are from different cultural and geographical backgrounds. Four participants are from private schools and two are from government schools. Five are male and one is female. Four are from education and two are from non education (pure mathematics) background. I think it makes my research more representative. I included all possible information that I got from the participants regarding the research issues that they expressed and shared during interviews and I found during their class observation (Guba & Lincoln, 1989).

Ethical Considerations

Ethical issues arise in discussions about codes of professional conduct for researchers and in commentaries about ethical dilemmas and their potential solutions

(Punch, as cited in Creswell, 2003). In the process of my research, initially I explained the purpose of my study to the participants to convince them. I convinced them that I would not disclose the information. I never tried to ask about their private information to make them feel embarrassed or uneasy. While analyzing the data obtained from the field, I tried to protect the privacy of the participants. I presented and interpreted the participants' understanding, ideas and perceptions as they were expressed and shared. I did not use their real or fictitious names. Instead I used alphabetical notation to denote them as McNiff (1992) says, "Do not reveal the real name of people or place unless you have specific permission to do so. Do not give participants fictitious name, those name may belong to other people somewhere" (p. 3).

Chapter Summary

In this chapter, I have tried to present the paradigm and method that I have adopted to conduct the research. I have presented my epistemology, ontology and axiology. Further, I have presented the data collection techniques, procedure and the method of data analysis and interpretation. I have also presented the quality standards that maintain the qualitiy of this ethnographic research. I have also mentioned the ethical issues of my study.

CHAPTER IV

PERCEPTION OF MATHEMATICS TEACHERS ON TEACHING MATERIALS

Chapter Overview

This chapter deals with the perceptions held by mathematics teachers on using materials in their instruction. This chapter includes the answer to my first research question "what perception do mathematics teachers hold on using materials in their instruction?" On the basis of the participant's responses about their perceptions towards materials I have organized this chapter into three subsections; Tools to understand mathematical concept, Tool for motivation, Tools to teach in an interesting way.

Tools to Understand Mathematical Concept

These days in my experience, the most difficult subject felt by school students is mathematics. Every year, SLC examination results show, one of the major subjects to have more students unsuccessful is mathematics. For some students mathematics is becoming a high scoring subject. What is the reason for mathematics to make some students unsuccessful and it is to be high scoring subject for some other students? There may be many reasons for it. In my experience, one of the reasons is the concept got by the students in the related topic. Some students can understand abstract mathematical ideas whereas others cannot. Those who can understand abstract mathematical ideas feel mathematics an easy subject and can score high in examination but those who cannot understand abstract mathematical ideas feel mathematics a difficult subject and cannot score in examination. In recent days, there

are several researches which deal about the nature of mathematics. And, many researchers tend to seek the reasons that make students failure rate high in mathematics. In this regard, there are several researchers who suggest that the use of teaching materials helps to minimize the failure rate in mathematics. Johana (2009) has reported that materials help students to understand mathematical ideas/concept/ relation. Manipulative has been proposed as tool in mathematics classroom because this tool may help students learn mathematics with understanding (Heibert et al., 1997). Similarly (Sherman & Richardson, 1995) report teachers' reason of using manipulative as students using manipulative have opportunities via senses of touch and sight providing students a strong foundation for understanding a concept. In this regard, T1 said:

> *"In the chapter reflection, I let students find the images of different points by keeping mirror in an axis of reflection and observing their images. Then I write some points and their images on the board and let students generalize to find the image for the point (x, y). I repeat this process for different axes of reflections. This helps student to conceptualize the mathematical ideas about reflection in different axis."*

The most common reason to use manipulative materials in mathematics classroom is that students using manipulative materials have opportunity to learn via senses of tough and sight providing students a strong foundation for understanding a concept (Sherman & Richardson, 1995). If students were not engaged in an activity to observe the images of different points under reflection in different axis instead teacher wrote the formula to find the images under reflection in different axes and used them to find the images of different points, students could find the images of different points but could not understand the concept about reflection. Manipulative materials

provide additional resources; manipulative helps to connect math with real world experiences and manipulative helps memory and understanding because of the physical movement required while using these tools (McNeil & Jarvin, 2007). Regarding materials as tools of understanding mathematical concepts T_2 said,

> *"While teaching about surface area of a cylinder, at first I demonstrate hollow cylinder and solid cylinder. I discuss different surfaces of hollow cylinder and solid cylinder. I measure radius and length of them and find their lateral surface area and total surface area of the solid cylinder by adding their different surfaces. I establish the formula for lateral surface area and total surface area of them by using their nets. I also find the total surface area of the cylinder by using the formula. Doing this, students get concept about lateral surface area and total surface area. They can find the area of the cylinder by different ways."*

Students taught to find surface area of a cylinder without making familiar with the cylinder but by using formula can calculate the surface area of the cylinder but do not know about the surfaces of the cylinder. They can solve the text book based routine problems but cannot solve the real world problems. They can calculate the surface area of the cylinder given in the book but cannot estimate the cost of painting the cylindrical water tank kept in their houses, at the given rate of painting. Using manipulative materials in teaching mathematics will help students learn to relate real world situation to mathematics symbolism (Schweyer, 2000) and can solve the problem. Manipulative materials allow students to see and feel concept in a concrete way (Sherman & Richardson, 1995). These tools help introduce what is abstract in mathematics as well as increase student understanding. In this regard T_3 said,

"Few years ago, when I was teaching only in a school, in class nine using wooden blocks, I demonstrated for the verification of $(a+b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$*. They took the blocks and practiced on their own in leisure time to verify it. Next day, they demonstrated it properly. From their explanation, I felt that they got good understanding of volume."*

When the students get manipulative material by the nature of children they play with the newfound toy or they observe it carefully. Dienes suggests that such informal activity is natural and important part of the learning process and should be provided in the classroom by the teacher. When T_3 demonstrated the proof of $(a+b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$ using wooden blocks students observed it carefully. When students got the blocks, they tried to prove themselves. They engage in different activities. Performing different activities, they perceived mathematical ideas. In this regard T_4 said,

"*I used to write formula, draw the figure and find the surface area of prism, pyramid, cone and the solid formed by joining two or more having same radii. Doing so students could calculate the surface area of solid using formula but they could not know the surfaces of the solids. Now a days, I show the solid, describe them about its different surfaces and find its total surface area by adding area of its different surfaces. Doing so, students identify the surfaces of the solids which constitute the total surface area. They calculate the areas of different surfaces of the solid and add them to calculate the total surface area of the solid. While finding surface area of a solid formed by combining two or more solids. I show the solids separately, discuss their different surfaces then I attach them to form a single solid and discuss the visible surfaces then find*

the surface area of the combined solid by adding the areas of the visible surfaces of the combined solid."

Calculating surface areas of solids, just applying formula but not discussing its different surfaces with the help of concrete solid, students could get the correct answer for total surface area of the solids but they could not know about the surface area of the solid. Observing the solids and finding the areas of different surfaces of the solids measuring actual lengths of their dimensions, students get the concepts of surface areas of the solids as well as they know to calculate the correct answer. Finding the surface area of the solid formed by joining two or more solids by using readymade formula rote learned by students, above average students can calculate the correct answer without knowing different surfaces of the combined solid but the students below average neither can identify the right formula to calculate the total surface area nor they get the concept about different surfaces of the solid. But if the students are taught using solid materials students are not needed to rote learn the formula. Observing material, students see its different physical properties and engage in different activities (Johana, 2009).They can imagine the different surfaces of the solid, find their areas and add them to get the total surface area of the solid. "Students using materials have opportunities to learn via senses of touch and sight providing student a strong foundation for understanding a concept" (Sherman & Richardson, 1995). In this regard T_5 said,

"One student of class 10, who was admitted in the school this year, neither understands Nepali nor English language properly. He is from ethinic background. In the class, I had used concrete materials like cylinder, cone, prism and pyramid in the chapter mensuration but not any other materials in other chapters. While checking answer sheets of examination, I found that he

had solved the problems related to pyramid, cone and cylinder in which I had used concrete materials but he had not solved other problems significantly in which I had not used materials. Not only he, most of the students had solved the problems related to the pyramid, cone and cylinder. I have felt that students had understood the chapter in which concrete materials had been used than the other chapters."

Children are the active individuals who genuinely construct and modify their mathematical knowledge and skills through interacting with the physical environment, materials, teachers and other children (Reusser, 2000). Student who does not understand Nepali and English language properly cannot communicate properly with friends as well as with teacher in the classroom and do not understand the concept. In the chapters where concrete materials are used, students can see a visual representation of the abstract content. If teacher have second language students in their classroom, activity may need to be more embedded in content to help students decrease the cognitive demand required for language and communication (Cummins, 1998). Activities using concrete materials have been found to be appropriate instructional methods for these particular types of students requiring high cognitive load due to the lack of language proficiency (Cummins, 1998).

Tools of Motivation

Though mathematics is the gateway of many areas of study and a critical filter in employment (Ernest, 1991, p. 274), many students are not motivated towards mathematics and they could not score high in an examination. There may be different reasons for mathematics to be boring and a difficult subject for the students. Much research has been done to find the reason, for mathematics to be a less interesting and low achieving subject. One of the reasons may be the lack of students' motivation

towards the subject. The major factor to be math anxiety is the way math is taught and the way teacher feels about math (Maria, 2013). The reason for math anxiety is the way math is often taught as there is only one way to do this and you need to learn it and do it right (Maria, 2013).

Two distinct types of academic motivation can be aroused in students. One is intrinsic motivation and the next is extrinsic motivation. Academic intrinsic motivation is the drive or desire of the students to engage in learning for its own sake. Students who are intrinsically motivated engage in academic task because they enjoy them. Their motivations tend to focus on learning goals such as understanding and mastery of mathematical concept. Students who are extrinsically motivated engage in academic tasks to obtain reward or to avoid punishment. (Middleton, & Spanias, 1999, p. 66). Regarding material as a tool for motivation, T_1 said,

> *"Students who cannot understand abstract mathematical ideas may see mathematical ideas in material. When they see mathematical ideas in material they will feel proud of themselves then they share the ideas seen with friends. They will be more encouraged and feel more confident. In this way they will be motivated towards learning."*

In my experience, usually bright students in a class are more active than below average students. The bright students discuss their confusion with the teacher and their friends and be clear about the confusion. But academically poor students hesitate to discuss their confusion and do not reduce their confusion. They feel that whatever question they ask to the teacher or other friends, that may be wrong and other, may laugh upon this. Due to this, academically good students become better day by day and the poor students become worse day by day. When poor students understand some mathematical ideas by the use of concrete materials, they will build up their

confidence and do not hesitate to discuss their confusion with others. They will understand more and they share their understanding with others. They will be more encouraged and take part actively in the learning process. Gradually they feel motivated towards learning. In this regard T_2 said:

> *"Before starting the chapter* home arithmetic *I tell students to bring bills of electricity, telephone and water earlier day. If students do not bring the bills, I will provide to the students. I tell students to discuss with friends in their bench about the procedure of calculation of total amount of the bill. I provide few minutes for discussion then I tell students to share their understanding about the procedure of calculation of the total amount of the bill. After listening to some students, I describe the procedure of calculation of the amount of the bill. Then I tell students to solve the problems of the text book. I observe the solutions of students and finally solve a problem of the text book and tell students to solve some other problems. Observing the actual bill, students know the application of the course and get motivated towards learning the course."*

Observing the actual bills students will be familiar with the bills. In my experience, whatever students learn in their course, they want to know the value of spending their time to learn the task (Posamentier, 2012). They do not want to be doing problems for the sake of doing problems. The usefulness of the topic can provide great motivation for students. When teachers can show the students examples of the values of mathematics in their present and future experience, students will be more accepting the things. The teacher and the students should be able to select mathematical applications that come from students' experiences. Presenting mathematics which is used in an occupation can also be motivating factor when

students know the math they are learning is needed to do that occupation. The most important strategy to build motivation is to help students to become aware of the mathematics needed in almost every occupation or career (Posamentier, 2012). Students need to see how the concept being taught is connected to real life. If the teacher is not able to help the students make that connection, the motivation to learn from this focus is gone. Students want to understand why they need to know something, not just what they need to know it for the test or because it is in the book. In this regard, T_3 said,

"*Using materials, students observe it, discuss with each other, investigate, question to friends and teacher. Doing this, students those who are not active in the learning process, gradually become active, gradually they ask questions to friends and teacher, share their findings or understanding and get motivated towards learning*".

When students get manipulative materials by the nature of children they play with the newfound toy or they observe them carefully. Dienes suggests that such informal activity is natural and important part of the learning process and should be provided by the classroom teacher. Dienes suggests that after the observation of the materials by the students, they should be instructed to perform activities related to the concept to be learned. Performing different activities, they perceive mathematical ideas. They raise different questions to their friends and teachers. They share their findings with their friends and teachers. In this way they participate actively in the learning process and feel gradually motivated towards learning. In this regard, T_4 said:

> *"I did not use materials before. I used to write formulas on the board, solve a problem using the formula, explain the condition to apply other formula then tell students to remember the formulas and use them to solve remaining*

problems of the textbook. Bright students could be able to apply different formula in different problems properly but below average students could not be able to identify the right formula for the problems and could not solve the problems. Bright Students, who could solve the problems correctly tried to solve other problems but below average students did not want to solve other problems. These days I use materials. Students observe them, discuss with each other then understand something about them. They share the mathematical concept they have understood with their friends. They feel that they are also capable to understand mathematical ideas and are encouraged to learn more. In this way they will be motivated towards learning."

In my experience, some students are not interested to learn mathematics. They are not motivated towards learning mathematics. It is due to their less understanding capacity of mathematical concepts and less problem solving capacity. Effective use of manipulative materials contributes to conceptualization and understanding (Hidden, 1997). Students using manipulative materials may be able to reach mathematical understanding (Gravemeijer, 2002). When they understand mathematical concept, they can solve the related problems and they will be interested to solve the problems and to take part actively in classroom activities. Gradually they will be motivated towards learning. It is very unlikely that students will sit for an hour and listen to the teacher talk and become intrinsically motivated to learn. They need to use manipulative items and be allowed to take their learning to another level (Posamentier, 2012).

Tools to Teach in an Interesting Way

For many people, mathematics 'stinks' (McNaugrt, 2010). There may be different reasons for mathematics to be less interesting subject for many people. Many

researchers are trying to seek the reasons for mathematics to be less interesting subject for many students. One of the reasons may be students' and teachers' attitudes towards mathematics. The work of Brady and Bowd (2005) suggests that one of the most significant indicators of negative attitude of pre-service teacher towards mathematics is their own personal experience as learners at school. Furthermore, their future professional practice as teachers of mathematics will be highly related to the way they personally experienced in the school. Another reason for mathematics to be less interesting subject is the traditional way of teaching. Research shows that many teachers tend to teach as they themselves were taught (Smith & Latosi, as cited in Naught, 2010). In this regard, T_6 said,

> *"In mathematics class mostly we follow the same way. Always students have to listen to the teacher, observe the solution done by the teacher on the board. Then solve the problems following process as the teacher has done. Not only in mathematics class, in all subjects students have to do the same, listen to the teacher being silent in the classroom, then write in copy. Using material, student experiences different than the classes without using it. Instead of listening to the teacher and observing on the board, they observe materials, engage in different activities, discuss with friends and teachers. Doing different activities students feel fun."*

In my experience, may be due to the evaluation system i.e. only to calculate correct answer, lack of student centered activities and lack of sufficient ideas to involve students, most of the mathematics teachers always follow the traditional method in their classroom. Students have to listen to the teacher, observe the procedure of solving problem by the teacher and follow the method of the teacher to solve many similar problems. Always following the same way students lose their

interest towards the subject. Use of materials in mathematics class differentiate the mathematics class from real math class where they taught rules, procedures and algorithms using textbooks, worksheets, paper and pencil task (Mayor, 2001). Another teacher T_5 said,

> *"Using materials even students who do not concentrate in a class and do not participate in discussion feel the class is a game and pay attention towards the activities done in the class. Gradually they try to show their more participation in the class. This arouses interest in them towards the subject."*

Chapter Summary

In this chapter, I have presented the beliefs of mathematics teachers toward materials. I have presented teachers' belief about material as tools of understanding mathematical ideas/ concepts/ relations for students, tools of motivation for study and tools to arouse interest for mathematics learning.

CHAPTER V

PRACTICE OF TEACHING MATERIALS

Chapter Overview

In this chapter I discuss the practice and use of materials by mathematics teachers in their instruction. Teachers' instructional practices have been found to be influenced by different variables such as their beliefs, knowledge, context, attitudes and previous experiences (Ernest, 1989; Wilkins, 2008). The effectiveness of teaching mathematics depends up on several factors; one of them is proper use of manipulative materials in their instruction. Improper use of materials may have adverse effect in students' achievement (Schweyer, 2000). All mathematics comes from the real world. Mathematics in a book is a translation of real word situation into a symbolic form for calculation. Materials that are improperly used will convince students that two mathematical worlds exist manipulative and symbolic.

I have organized this chapter under four subsections 1.preparation of materials, 2.storage of materials, 3.use of materials and 4.method of using materials. In this chapter I have tried to address my second research question; in what way do mathematics teachers use materials in their instruction?

Preparation of Materials

To use materials effectively, teachers should be well prepared about the way of instruction and the materials should be prepared in advance. The materials should be selected in such a way that as far as possible students should be familiar with them. The materials used should be related to the students' real world (Schweyer, 2000). For

example an abacus is not used in daily life, instead stones, rubber bands, beans are more appropriate. Here I discuss how mathematics teachers prepare the materials that they use in their instruction. The information given below is obtained through interview and observation. Regarding the preparation of materials, T1 said:

> *"School buys the materials according of teachers' demand. But we inspire students to bring which are available in their surroundings. Doing so students will be directly involved. If the materials are not available in the surroundings, school will manage it."*

In the discussion, he said that he had learned to develop materials in material development class in K.U. He knows to develop many materials. But he inspires his students to bring if they are available in their surroundings. He provides ideas to students to develop materials and tells them to prepare. In the class, students observe the materials that they had bought. They explore different mathematical ideas under teachers' instruction. If students could not prepare then the teacher would prepare or buys. Good teachers are masters at modeling appropriate strategies for children. They bring their own automaticity, or fluidity to master instructional skill in mathematics when they not only use the number, algorithms and process needed to solve a specific problem, but also show through modeling (Kelly, 2006). He further said that, "They use materials only in the beginning of the chapter. Students are informed earlier day to bring otherwise teacher provides in the classroom. Teacher demonstrates a model and instructs activities. Students do the activities and explore mathematical ideas." Regarding the preparation of materials, T2 said:

> *"Two years ago we had done science and mathematics exhibition in our school. In the exhibition, students had demonstrated cylinder, prism, pyramid, cone, tetrahedron, octahedron, dodecahedron, icosahedrons and their nets;*

bar graphs and pie charts representing number of male and female students of different classes; $(a + b)^2 = a^2 + 2ab + b^2$, $(a - b)^2 = a^2 - 2ab + b^2$, *factorization of trinomial expressions such as* $(2x^2 + 5xy + 3y^2$, $2x^2 - 5xy - 3y^2)$ *using chart papers;* $(a + b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$ *using set of cubes and cuboids. All the demonstrated items were prepared by students in my supervision. I have kept those items. These days I use them in my instruction."*

From this statement I came to know that for the chapters, mensuration, algebra and statistics, T_2 uses materials prepared by the students in his supervision. He provides ideas and the students prepare. In an interview, he further said that reflection, rotation demonstrating materials, he had made himself and sphere, hemisphere, cylinder, cone, prism and pyramid made of wood are bought from the market. In an observation, I found that he had used cylinder made of wood, which was bought from the market and its net made of chart paper was prepared by students. In this regard T_3 said:

"I know to prepare cylinder, prism, pyramid, cone, clinometer and some other item using chart papers. I have also learned to demonstrate some geometric concepts using paper cutting and folding process. But I do not prepare now a days. I used to prepare it, supervise students to develop it. These days I am so busy. In early morning to late night I have to take class, so neither I can prepare nor can I help students to prepare these materials. If materials are available in school, I will use them. The materials like graph chart, geometrical instruments and solids like cylinder, cone, pyramid and sphere are available in the school and I use them."

Due to the lack of time, teachers do not prepare materials. To sustain in a society not only teacher, every person has to work more time. It is difficult to fulfill

their needs by the salary they receive from a school. So, teachers have to work in more than one institution. They are not satisfied with their job. Teachers with high job satisfaction tend to give more support to their students (Opdenakker &Van Damme, 2006). In this regard, T_4 said,

> *"Till now school has not been able to buy apparatus and chemicals for science practical. Without managing apparatus and chemicals for science practical, it is not possible to manage budget to buy materials for mathematics. So I have made most of the materials that are used in my instruction. I have made cylinder, cone, pyramid, prism by using chart paper. I have also kept those solids prepared by the students. I have kept spheres and hemisphere made of wood made by a carpenter."*

In S.L.C. curriculum, 25% marks is allocated for science practical but not any marks for mathematics practical. So, in most of the schools, school administrators give less priority to mathematics materials than to science practical. School gives more priority to buy equipments for science practical than only to buy materials for mathematics. So due to the lack of budget, teachers develop materials needed in their instruction themselves using low cost materials and they buy with limited budget which they cannot develop. In this regard, T_5 said,

> *"I am teaching in three schools. I have not taken any classes or training to prepare materials. But I have good knowledge to make cylinder, cone, pyramids and prisms. I have not prepared any materials that I use in class. While teaching mensuration, I ask for paper with students then make cylinder, cone and prisms with the paper roughly in the class. In one of the school cone, pyramids, cylinder, sphere and hemisphere are kept and I use them in the class."*

Teachers who are teaching in many schools are busy and do not prepare the materials needed in their instruction. They do not use their time other than their school time to do the work of school. They use the materials if they are available in the school. If they feel their need, they prepare in the class roughly and use. In this regard, T_6 said,

> *"I am a student of pure science. Neither it was in the course to develop material nor have I taken any training to develop it. I do not have enough idea to develop material. So neither I develop nor do I provide idea for students to develop it. Geo board, graph chart, cylinder, cone, prisms and pyramid were already collected. I use them in the classroom."*

Teachers who are from pure science or mathematics background were not found to have taken any course related to teaching methodologies and material development. If they have not taken any training, they may not have enough ideas to develop appropriate materials. So neither they can construct nor can they provide ideas to construct appropriate materials.

Storage of Materials

Under this topic, I present about the storage of materials by mathematics teachers (participants). This topic deals with the present condition of the materials the mathematics teachers have stored.

Observing the materials stored by T_1, I found that they were stored in two places, in the primary level building and next in the secondary level building. The materials kept in the primary level building were for primary level students and the materials kept in the secondary level building were for secondary level students. Some of the materials like graph chart, geometrical instrument, cone, cylinder, sphere were common for both places. In my experience, cone, cylinder, and sphere in the

primary level are used to know their shapes and their dimensions (radius, height). But in secondary level it is used to build up concept related to surface area and volume and to derive the formula to calculate the total surface area and volume. Some of these materials were made of hard paper and some of them of wood. Some marbles, birthday cap, two dimensional shapes like quadrilateral, rectangle, square, parallelogram, rhombus, trapezium, circle, different types of triangles, pentagon, hexagon were kept in the primary level block. Some statistical charts like pie chart, bar graph were also kept there. clinometer, trigonometric ratio measuring instruments, some rectangular shaped small mirrors, reflection and rotation demonstrating materials made of paper and a set of cubes and cuboids, made of paper for the demonstration of $(a+b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$were also found in the secondary level block. In an observation, I found that most of the items were few. There were not enough items for each student to manipulate individually. In order to facilitate materials at any grade level, the required materials must be plentiful enough (in number) to allow each student to have access to complete set (Kelly, 2006).

Observing the materials stored by T_2, I found that materials for demonstration of $(a+b)^2=a^2+2ab+b^2$, factorization of trinomial algebraic expressions, some telephone bills, electricity bills ,cylinders, cones, spheres, prisms, pyramids , some made of paper and some of wood, pie-chart and bar graph showing the number of male and female students of different classes. All the materials were kept in the staff room, where the materials were not easily reachable for the students. In order to facilitate materials at any grade level, the required materials must be stored in such a way it will be physically reachable for all the students (Kelly, 2006).

Observing the materials stored by T_3, I found some solids (prism, pyramid) made up of wood, graph chart and geometric instrument in a rack in the staff room. T_3 said that he had not made and kept them. They were already there.

In an interview T_3 said that he is taking only two periods in the school. He is also teaching in other school and college. From early morning to evening he is busy. So, he may not dedicate enough time to collect materials. Those who are fulltime teacher, and stay full time in a school can provide certain time to prepare and to collect materials. But those, who are part time teachers and teach in other schools, are busy and cannot provide enough time to prepare and collect materials.

Observing the materials stored by T_4, I found that materials were kept in a separate shelf in the science laboratory. Solid materials (cylinders, pyramids, prisms, cones, spheres and hemispheres) made of paper and wood were found. T_4 said that wooden materials were bought and the materials formed by paper were made by him. A set of cubes and cuboids, made of paper for the demonstration of $(a+b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$, geometric instrument and graphic chart were also found. He said that graph chart was bought and the set of cube and cuboids were made by him.

In the case of T_5, a set of geometric instruments and a graph chart were stored. The set of geometric instruments was kept in the staff room and graph chat in the library. According toT_5, these materials were not brought by him.

Though T_5 is from pure science stream and he has not taken any formal training or courses related to teaching mathematics, he has a good knowledge to develop solids materials used in the mensuration chapter. He does not prepare the materials before going to the class. He develops the materials roughly in the class with papers and uses them for concept development. He is teaching in three schools.

He is busy and may be tired; preparing materials requires a lot of work by a teacher (Zakaria & Iksan, 2007). So he does not prepare and store them.

Observing the materials stored by T_6, I found that a geo-board, some solid materials (cone, cylinder, pyramid), a set of geometric instruments and a graph chart were stored. All the materials were kept in the teachers' room.

T_6 is neither from education stream nor has she taken any training on teaching mathematics. She does not have enough knowledge about materials used in teaching mathematics. She does not use materials. So she does not store them. She said, those materials found in the teachers' room were kept by another teacher.

Methods of Using Materials

Under this topic, I deal with participants' method of using materials. To know about the method of using materials, I observed the classes of each participant and also asked some questions to them. Regarding the method of using materials, T_1 said,

> *"At first I tell students to observe the materials then I demonstrate and instruct activities. Students do the activities. I instruct them different activities to build up mathematical concept. Sometime I use material to provide ideas to solve text book problem if they do not get idea to solve the problem."*

Here, I would like to present an activity of using materials done by T_1 in class nine. The activity was done in the beginning of the chapter reflection. There were 35 students in the class. Earlier day he had informed students to bring graph paper and a rectangular shaped mirror of small size. Most of the students had brought graph paper but only half of the students had bought the mirror. Some students had bought circular mirror. The following activities were done by the teacher and the students.

Teacher: You may have heard the word 'reflection'. What do you know about reflection?

Students: (some of the students replied), Reflection of light what we have learned in Science.

Teacher :(pasted a poster consisting Machapuchre Himal and its reflection on Phewatal on a wall and told) the inverted one seen under the surface of water is the reflection of Machapuchre Himal on Phewatal. (He showed a bird above the water surface and its image below the water surface and explained) The below one is the reflection of the above on the lake. The surface of the water is the surface of reflection. (He asked the students), what more do you notice in the poster?

He listened to them turn by turn. He showed the peak of the mountain and its image then told that the below one is the reflection of the above one. He joined the peak and its image with scale. Similarly he joined an eye of the bird and its reflection with scale and told that the line is perpendicular to the line which represents the surface of the water. He told the distances of the objects and their images from the line of reflection are equal. He drew a flag of Nepal on the board, drew a line and kept a mirror on the line facing the reflecting surface towards the flag then asked students about the position of the image of the flag when viewed on the mirror. He observed on the mirror, drew its image then told the later drawn one is the image of the formal drawn when reflected in the mirror. After that students who had brought mirror followed the process as the teacher in their copy. Teacher provided some mirrors so that in a bench student got at least one and provided few minutes to follow such activity on their own. He drew a point and axis of reflection on the board and asked students, how to find the exact position of its image? He drew a perpendicular line from the point on the line using set squares, extended the line back to the mirror line, measured the distance of the point from the line and marked the image point on the extended line so that the point and the images are equidistant from the mirror line. He

drew some points in a graph chart, wrote their coordinates and kept the mirror vertically along X-axis then asked the students, what are the coordinates of their images formed? He wrote the coordinates of the points and their images as

A (2, 3) → A (2,-3)

B (-2, 1) → B' (-2,-1)

C (-2, -3) → C' (-2, 3)

D (3, -2) → D' (3, 2)

Then he asked the students, what is the relation between the X-coordinates of the points and their images? What is the relation between the Y-coordinates of the points and their images? Some students replied x-coordinates of the points and their images are same but in the case of Y-coordinates + sign change to – sign and vice-versa. Then the teacher wrote the relation between coordinates of the points and their images as for any point P(x, y)

P (x, y) → P'(x,-y)

He followed the same process for different axis of reflection.

T_1 uses materials to explore students' mathematical concepts. He lets students observe the materials and make them familiar with them. In the class, he pasted a poster of Machapuchre Himal and its reflection on Phewatal on a wall and told students to observe it. To explore students with manipulative, it is very important to them to become familiar with the items and make observation (Schweyer, 2000). He instructs different activities up on the materials. He provided the mirror to students and told them to draw a flag of Nepal and to observe its image after reflecting its image in X axis using the mirror. He let students observe the images of different points after reflection in different axis of reflection using the mirror. These activities

help students learn to relate real world situation to mathematical symbolism (Schweyer, 2000).

T_2 also has similar method of using materials as T_1. In an interview he said "I use material for the concept development and to establish related formula." The following is an activity done by T_2 while teaching surface area of cylinder in class eight.

T_2: (shown a cylinder) what is this?

Students: Cylinder.

T_2: Can you give some other examples of cylinder ?

Students: Drum, filter, hotpot.

T_2: How many surfaces are in this cylinder?

Students: (some say three, some say one but most of them were silent).

T_2: (showing three surfaces explained about curve surface and plane circular surface then asked) How to find the area of plane circular surface?

Students: Using the formula πr^2.

T_2: How to find the area of a curved surface?

Students: (silence)

T_2: (converted the cylinder into the net and showed a rectangle formed by curved surface and said) area of curved surface is equal to the area of this rectangle. (He further explained as) Area of rectangle=l X b.

l=circumference of the circle=2πr

b= height of cylinder

So, area of a rectangle=2πrh

At last he established, total surface area=area of 2 circles + area of curved surface.

$= 2\pi r^2$+2πrh

$=2\pi r(r + h)$

He measured the radius and height of the cylinder then found the total surface area of the cylinder by using the formula. He also measured the area of circles and rectangle of the net of the cylinder and found its total surface area by adding them. He said that total surface area found by adding areas of its different surfaces and by using formula are the same.

T_2 uses materials to explore students' mathematical ideas. He demonstrates the concrete objects and asks questions related to them. Children construct knowledge through questioning and building on children's answer while they constructed knowledge (Piaget, 1965). He uses concrete objects to establish mathematical formula. He instructs different activities to connect students' previous knowledge. In the above mentioned activities he established total surface area of cylinder by connecting students' previous knowledge, formula of area of circle and area of rectangle to classroom activity. If teachers provide opportunities in which students can connect their previous knowledge to classroom activities, students may be better able to build their knowledge with understanding (Brooks & Brooks, 1998).

Regarding the method of using materials, T_3 said "I demonstrate some solid materials (cylinder, prism, pyramid, and cone) to recognize their shapes and for concept development." The following is an activity done by T_3 in his instruction.

He showed a square based pyramid made of wood and said this is a square based pyramid. He showed its square base and said it is its base. He showed its triangular faces then said these are its triangular faces. It has four triangular faces. All the faces are equal in area. He showed sloping edge of the pyramid and said these are its sloping edges. All the sloping edges are equal in length. He drew a slant height on one of its triangular face and said it is called slant height of the pyramid; it is also the

height of the triangle, slant height in all the triangles are equal in length. He drew a figure of square based pyramid in the board then matched different surfaces of the solid to the surfaces in the figure. He drew slant height and vertical height in the figure then explained the technique of finding vertical height or slant height or sloping edge or length of the base when any two of them are known. He explained the formula,

Total surface area of pyramid = area of four triangular faces + area of squared base

$$=4 \times \frac{1}{2} al + a^2 = 2\ al + a^2$$

Volume of the pyramid = Area of the square base × Height of the pyramid

$$= a^2 h$$

Where, a = length of square base, l = slant height of the pyramid and h= height of the pyramid.

He drew a pyramid on the board, supposed the measurement of length of the base and vertical height of the pyramid and found the volume and total surface area of the pyramid. He explained the technique of finding vertical height or slant height or sloping edge or length of the base when any two of them are known. He drew a pyramid on the board, supposed the measurement of length of the base and slant height of the pyramid and said students to find the volume and total surface area of the pyramid.

T_3 uses concrete materials to make students recognize the shapes of solids (prism, pyramid, cylinder, cone, sphere, and hemisphere) and their parts (slant height, vertical height, sloping edge, base, length of base and radius). In an above mentioned activity, T_3 showed base, triangular faces, slant height, sloping edge of the pyramid using concrete pyramid. He connected mathematical ideas of figure to the concrete object. Without using concrete solid, some students may not visualize base, triangular

faces, slant height, sloping edge of the pyramid. Teachers can use various tools to help students make connections and achieve mathematical understanding. Concrete materials have been proposed as a way to make mathematics more concrete and manageable for students (Hiebert et al., 1997). Regarding the method of using materials, T_4 said:

> *"I used to write formula, tell students to copy and memorize the formula then tell them to find the surface area of prism, pyramid and cone using the formula. Doing so students could calculate the surface area of solid using formula but they would not know about the different surfaces of the solid. Now a day, I show the solid, tell them about its different surfaces and find its total surface area by adding area of its different surfaces. Doing so, students can identify the surfaces which constitute the total surface area. Students need not to remember more formulas. While finding surface area of a solid formed by combining two or more solids, I show the solids separately and in combined form, discuss visible and invisible surfaces when attached two or more solids then find the area of the solid by adding only area of visible surfaces."*

Here I would like to present classroom activities done by T_4 regarding the use of materials in class 10. There were about 50 students in the class.

Teacher: (shows a cylindrical wooden block and asked the students) what is this?

Students: Cylinder.

Teacher: How many surfaces has it got?

Students: Three.

Teacher: What are the surfaces?

Students: Two are circular surfaces and one is curve surface.

Then, the teacher kept the palm over the circular plane surfaces, moved on it and told these are two circular surfaces. Similarly kept the palm on the curved surface moved on the surface and told it is a curved surface. Then asked the students how to find the area of these surfaces separately.

Students: Area of each circle is πr^2 and area of the curved surface is 2πrh.

The teacher showed a hemisphere and asked the students: What are its surfaces?

Students: One is curved surface and the next is plane circular surface.

The teacher kept the palm over the circular plane surfaces, moved on it and told this is a circular surface. Similarly, he kept the palm on the curved surface moved on the surface and told it is a curved surface. Then he asked the students how to find the area of these surfaces separately.

Students: Area of the circular surface is πr^2 and area of the curved surface is $2\pi r^2$.

Then the teacher attached the circular surfaces of hemisphere and cylinder having same radii and formed a solid then asked the students how many surfaces it has and what they are.

Most of the students told five and a few of them told three.

The teacher asked some selected students, how five or three? Some told three surfaces are of cylinder and two are of hemisphere. So surfaces of combined solid are five. Some told one curved surface of hemisphere, one curved surface of cylinder and one circular surface of cylinder. So, the number of surfaces of combined solid is three.

The teacher showed the combined solid and described its surfaces as while combing the solids circular surfaces of each solid are attached and the surfaces are covered by body of the solids. These two surfaces are not visible in the combined solid. Curved surface of the hemisphere, curved surface of the cylinder and a circular surface of the cylinder are visible. Only these three surfaces can be taught in the

combined solid. So only these three are the surfaces of the solid. Then he asked the students how to find the surface area of the solid. He later said that the total surface area of the solid is the sum of a circular and curved surface of the cylinder and the curved surface of the hemisphere.

T_4 uses materials for demonstration. He does not provide materials to students. This may be due to the less number of materials or more number of students in the classroom. To use material effectively, each student needs material to manipulative independently. Demonstration by the teacher or by one student is not sufficient (Schweyer, 2000). He uses material for concept development. In an above mentioned activity, to conceptualize the surfaces of solids, he kept his palm on different surfaces of cylinder and hemisphere. To make students understand about the existing surfaces of the combined solid of two solids, he practically attached the circular surfaces of cylinder and hemisphere and discussed the visible surfaces. Regarding the method of using materialsT_5 said:

> "*I demonstrate cylinder, cone, prism and pyramid to make students recognize their sloping edge, slant height, vertical height, radius, base, and different surfaces."*

T_5 uses concrete materials by demonstration as Howard et al (1997) found in their study that 83% primary and 67% secondary level teachers use materials by demonstration from the teachers. T_5 demonstrate cylinder, cone, prism and pyramid and describe about their different parts.In this regard T_6 said:

> *"I display chart papers with data presented in different form (individual, discrete and continuous) then explain them by comparing. I show solids (cylinder, prism pyramid, cone and sphere) and describe about their surface."*

T_6 uses materials for demonstration by herself as most of the teachers do (Howard et al, 1997). She demonstrates data presented in different forms (individual, discrete and continuous) and concrete objects (cylinder, prism pyramid, cone and sphere) to help students conceptualize different forms of data and different surfaces of the solids.

Use of Materials

Mathematics teachers should use teaching strategies that promote students' mathematical understanding (NCTM, 2000). One strategy intended for that purpose is the use of manipulative materials (Hiebert et al., 1997). Psychologists and learning theorists have supported the use of these tools during mathematics instruction for many years. Learning models based on ideas of some of these theorists, such as Bruner and Piaget, help understand how these tools facilitate the learning process in mathematics classroom. The effective use of manipulative materials in mathematics classroom helps teachers to facilitate students with understanding and conceptualization rather than drill and practice procedures. It provides an opportunity for the teachers to access and meet the needs of students as they construct personal mathematical knowledge. Using manipulative materials may make the instruction period longer initially, but students retain the knowledge better and will require less review time later (Schweyer, 2000). Regarding the use of materials, T_1 said:

> *"As far as possible I use materials in every chapter. Mostly I use materials in the beginning of the chapter. In comparison to class nine, I use less material in class ten. In every chapter, as far as possible, the first day we spend on materials. If needed, we use materials in other days too. Before, I did not use materials frequently. There was another principal in our school. He argued that students learn mathematics by practice so they should solve all the problems of the text book. So I did not use materials frequently to complete the*

course on time. Now days, we have another principal. He is also from educational background. He has understood the importance of materials. These days I do not engage students to do more problems of same type. I select some problems of the text books of different types so that we can complete course as well as provide time to use materials and do different activities in the class."

T_1 uses materials in every chapter as far as possible. In comparison to other classes he uses less material in class ten. This may be due to the pressure to complete the course earlier. In every chapter, the first day he spends on materials to build up concept. He does not tell students to solve all the problems of text book. He tells students to solve only the selected problems of the text book so that students will solve varieties of problems and can provide time for material. In this regard T_2 said;

"I use materials in algebra, mensuration, home arithmetic and statistics. I use the materials prepared by students, myself and some commercially prepared materials. Usually, I use materials in the beginning of chapter."

T_2 uses materials in most of the chapters. He employs students –made, teacher-made and commercially prepared materials. It is very unlikely that students will sit for an hour and listen to the teacher talk and become intrinsically motivated to learn. Manipulative materials can be used to build interest and help students gain an understanding of the concept (Posamentier, 2012). He uses materials in the beginning of the chapters. The effective use of manipulative materials in mathematics classroom helps teachers to facilitate students with understanding and conceptualization rather than drill and practice procedures. It provides an opportunity for the teacher to access and meet the needs of students as they construct personal mathematical knowledge (Schweyer, 2000). Regarding the use of materials, T_3 said:

"I used materials frequently in classroom before. But now a day, I use only prism and pyramid which are available in the school. I know to develop and use them in a classroom. But being more busy and exam oriented, I do not use."

T_3 is a qualified teacher. He has done master in teaching mathematics from a reputed university. He knows how to prepare materials and use them effectively in instruction. He used materials frequently when he was a novice teacher. Now he is established as an experienced teacher and he is not using materials frequently as Gilbert and Bush (1988) found in study of 220 teachers that less experienced teachers use materials more often. Now a day, he is busier than before. These days, being busy he cannot manage time for preparation. Preparation is needed to manage any type of activities in classroom (Upadhaya, 2007). Effective use of manipulative materials contributes to conceptualization and understanding rather than drill and practice procedure. If mathematics is taught using manipulative materials, then the method of evaluating mathematical achievement must also change. Just calculating correct solution to mathematics problems is not sufficient. Concept development and understanding should be valued more highly (Schweyer, 2000). Regarding the use of materials in mathematics classroom, T_4 said:

"It is not possible to use materials in all the chapters. I use solids (cylinder, prism, cone, pyramid, sphere and hemisphere), their nets and skeletons, set of cubes and cuboids for the demonstration of $(a+b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$ *and two dimensional geometric shapes."*

Teachers' instructional practices have been found to be influenced by different variables such as their beliefs, knowledge, context, attitudes and previous experiences (Ernest, 1989; Wilkins, 2008). Teachers may not have enough knowledge or

experience about the use of materials in all the chapters. Preparation is needed to manage any type of activities in the classroom (Upadhaya, 2007). Teachers may not provide enough time to prepare materials. Using materials in every chapter, courses cannot be completed on time. So, teachers do not use materials in all the chapters. T_4 uses concrete materials in mensuration, algebra and geometry. He uses solids (cylinder, prism, cone, pyramid, sphere and hemisphere), their nets and skeletons, set of cubes and cuboids for the demonstration of $(a+b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$ and two dimensional geometric shapes. In this regard T_5 said:

> *"I do not use materials in all the chapters. I use cylinder and triangular prism in class eight and cylinder, cone, prism and pyramid in class ten. I do not use readymade solids. In the classroom, I ask for paper for students and make the solids roughly by using the paper."*

Here I would like to present activities done by T_5 in class nine. It was the second period of the school. Teacher entered into the classroom. Most of the students had turned the chapter of the book. It was the second day for the chapter 'enlargement'. Few minutes, they discussed their previous work. Then the teacher solved a problem of an exercise in which he enlarged a point with centre origin and scale factor 2. Then he solved another problem of exercise in which he enlarged a triangle and drew the triangle and its image on the board by drawing the axes of coordinates. He discussed the negative and positive scale factors. He solved a problem of exercise in which he found (approximately) centre and scale factor of enlargement by drawing a triangle and its images on the board then he assigned some problems for homework.

This activity shows that T_5 does not use materials in his instruction. He could use graph chart to draw a triangle and its image while finding centre and scale factor

of an enlargement. In an observation of the materials stored by him, I found that the graph chart was hanging in the library which was locked. I realized that he does not use even a graph chart. Use of materials in an instruction, involving students in different activities also depends upon the culture of the school or the department. There may not be the culture of using materials in the mathematical instruction. Regarding the use of materials, T_6 said:

> *"I am a student of pure science. I have neither taken any training related to the use of materials nor was it in the course. So, I do not have good knowledge about them and I do not use them frequently. cylinder, cone, prism and pyramid are kept in school. I use them to show their different surfaces."*

T_6 is a student of pure science. Neither she has learned in the course about the use of material nor has she taken any training. So, she has not good knowledge about its use. Teachers' instructional practices have been found to be influenced by different variables such as their beliefs, knowledge, context, attitudes and previous experiences (Ernest, 1989; Wilkins, 2008). Cylinder, Cone, Prism and Pyramid are kept in school. Therefore, she uses them to show their different surfaces.

Chapter Summary

In this chapter I discussed the practice and use of materials by participants. I have presented teachers' practice of materials in their classroom under four different heading: preparation of materials, storage of materials, methods of using materials and use of materials.

CHAPTER VI

BENEFITS AND CHALLENGES OF USING MATERIALS

Chapter Overview

This chapter deals with benefits and challenges of using materials in mathematics classroom. In this chapter, I talk about the answer to my third research questions. “How do teacher explain benefits and challenges of using materials in mathematics classroom?”. I have organized this chapter into the following subsections: benefits of using materials and challenges of using materials.

Benefit of Using Materials

Mathematics teachers should use teaching strategies that promote students’ mathematical understanding (NCTM, 2000). One strategy intended for that purpose is the use of manipulative materials (Hiebert et al., 1997). Psychologists and learning theorists have supported the use of these tools during mathematics instruction for many years. Learning models based on ideas of some of these theorists, such as Bruner and Piaget, help understand how these tools facilitate the learning process in mathematics classrooms. It is important to mark out some of the necessary benchmarks for effective manipulative use. First, it is essential for teacher to realize that impact of referring to manipulative as tools to help students learn math more efficiently and effectively rather than as toys or playing things. If manipulatives are referred to as toys, students will see them as something to play with rather than as tools to work with to better understand mathematics (Kelly, 2006). Second, manipulatives must be introduced in a detailed format with a set of activities

expectations held firmly in place for students to begin to develop a respectful knowledge base about using manipulatives for math learing. Third, manipulatives need to be modeled often and directly by teachers in order to help students see their relevance and usefulness in problem solving and communicating mathematically. And finally, manipulatives should be continuously included as a part of an exploratory workstation (Kelly, 2006). Teachers who consistently and effectively model manipulatives in front of all students will automatically offer all students a belief that using concrete objects to understand abstract concepts is acceptable and expected. Just as encouraging students to develop mental models helps to broaden and enhance complex mathematics learning. If students feel that manipulatives are only used by those who can't or don't understand or are less able, they will develop a negative attitude about manipulative. In this section, I focus my discussion on how mathematics teachers explain the benefits of using concrete materials in their instruction. In this regard, T1 said:

> *"The mathematics what we teach to students is the collection of activities of our daily life. If that mathematics is taught by linking with daily life activities or using objects used in daily life it would be definitely easy for students to solve mathematical problems. So use of materials helps students to understand mathematics easily. It also helps to teach in an interesting way".*

All mathematics comes from the real world. Mathematics in a book is a translation of real word situation into a symbolic form for calculation (Schweyer, 2000). For example, putting three goats with five goats to get eight goats is the real world situation but in mathematics, we say 3+5 = 8. These are not two different worlds but they are in the same world expressing the concepts in different ways. Learning occurs only when students (learners) process new information or knowledge

in such a way that it makes sense to them in their own frames of reference (their own inner words of memory, experience and response) (CORD, 1999). For example, 2x+3y+4x+y = 6x+4y may not be understood by some children but they can be made to understand by linking with 2 boys + 3 girls + 4 boys + 1girls = 6 boys + 4 girls. "Mathematics in its purest sense is an abstraction. It exists and it is extremely useful in describing and predicting events in the world around us. It does this by creating abstract structures that have properties or attributes similar to its real world counterpart" (Post, 1981). If the model behaves in the manner that truly parallels the original, then it becomes possible to manipulate and use the model to make conclusions and/or prediction about its counterpart of the real world. Lesh (1979) has suggested that manipulative materials can be effectively used as an intermediary between the real world and the mathematical world. He argued that such use would tend to promote problem solving ability by providing a vehicle through which children can model real world situations. In this regard, T2 said:

> *"Students taught using materials do not need to remember formula. They can solve problems without formula. I teach my students to find the surface areas of solids by using the real object. I demonstrate the object, measure the dimensions of its surfaces, find their areas and add them to find the total surface area of the solid. I and my students do not know the single formula to find the total surface area of pyramid, prisms, hemisphere and other combined solids but we can find its total surface area by adding the areas of its all surfaces. Before S.L.C examination, for a few months, I took tuition classes in another school. Students of that school were not taught to find total surface areas of solids by adding the areas of their different surfaces. Single formulas to find their total surface areas were written on the board, students copied and*

memorized them and used them to calculate their total surface areas. They knew to calculate the total surface area of pyramid by using the single formula memorized by them but they failed to identify slant height, vertical height, sloping edge and length of the square base while putting their measurement in the formula and could not calculate the correct total surface area of the object."

Students using concrete materials can see a visual representation of the abstract content helping students make connections between content and such representation (Johana, 2009, p.19). This connection allows students to manipulate the mathematical content in a more concrete and manageable way. Students taught using concrete materials can visualize the material and link the mathematical problem to the material and solve the problem. Students working with concrete materials can also make mathematical content meaningful by connecting it with their experience of using materials (Johana, 2009, p. 19). Students who have not used concrete solid but memorized formula can calculate correctly if they identify the correct measurement of the dimensions. But they may not be able to identify the proper dimension and the measurement of the solid. In this regard, T3 said,

"By the use of concrete materials especially below average students who cannot understand mathematical concepts easily will be more beneficial. They will understand the mathematical concept and can solve the text book problems. Use of concrete materials makes the classroom interesting."

Piaget considered the developmental stages of youth ages 7-11 to be a concrete operational stage where children need and are able to have concrete experiences. Children over the age of 11 years old are in the formal operational stage where children are able to have more abstract thinking and need less concrete

experiences. Piaget identified two different ways of having concrete experience using objects: physical experience and logico –mathematical experience (Kohler, 2008). Physical experiences relate to looking for physical properties of objects that students manipulate, whereas logico- mathematical experiences refer to abstractions reached because of the interaction with the object (Kohler, 2008). However, people have critiqued Piaget's stages (O' Hagan & Smith, 2002; Post, 1980). For example, the need of concrete experience is not limited to the 7-11 years old learners; those experiences are beneficial for young students (O' Hagan & Smith, 2002) as well as for older students (Post, 1980). Moreover, Montessori and Piaget share the idea that the teachers' role in the classroom is as a facilitator of students' experiences in constructing their own knowledge, and they both support the idea of using tools to help learning processes (Post, 1980; Zucherman, 2006). Lessons including concrete materials are fun and engage students in class activities that involve work with these tools (Moyer, 2001; Herbert, 1985). Use of manipulative materials make students feel different from real math where they taught rules, procedures and algorithms using textbooks, notebooks, worksheets and paper and pencil task (Moyer, 2001, p. 185). In this regard, T4 said:

> *"For bright students, who can visualize abstract mathematical ideas, use of materials may be less important but for students, who cannot visualize abstract ideas, they help connect the mathematical ideas seen in concrete material to the problems and solve the problems. Students taught without using concrete materials can solve textbook problems using the formula but they fail to solve similar type of practical problems. If students are taught using concrete materials they can solve the real life problem too. I used to write formula on the board, tell them to copy and memorize then I solve some*

problem using the formula and tell them to solve other problems of exercise. Doing so, some students could not select appropriate formula and could not solve the problems correctly. Now a day, as far as possible, I use concrete materials. Instead of solving text book or other word problem, I create a problem related to the material and using the measurement of the material, I solve the problem. Doing so more students are being able to select appropriate formula and solve the problem correctly."

In my experience, all students cannot see mathematical ideas/concepts/ relations which are in written form but they can see those ideas in concrete form. Children are active individuals who genuinely construct and modify their mathematical knowledge and skills through interacting with the physical environment, materials, teachers and other children (Reusser, 2000). For the students those who can see mathematical ideas which is in written form, concrete materials may not be so beneficial but for those who cannot, concrete materials are very important for mathematical understanding. One of the best way in which mathematical ideas may be developed or applied is through activities with physical material or manipulative (Schweyer, 2000). In my experience, students taught by memorizing formula feel difficulty to solve practical/ real life problems. They feel difficulty to relate real life problems to mathematical symbolism. Using manipulative materials in teaching mathematics helps students learn to relate real life situation to mathematic symbolism (Hiddens, 1997). Employment of concrete manipulative with modeling and guided practice help students determine the correct procedures to use when computing the area and perimeter of various shapes they encounter in everyday life (Cass, M., Cates, D., Smith, M., & Jackson, C., 2003). In this regard, T5 said,

"In this school, solid materials needed in the chapter mensuration are not kept. Usually, I prepare the solids roughly in the classroom and demonstrate them to show their different dimensions and surfaces. In class 10, I explained about prism by drawing the figure on the board. I felt that students became confused about its different surfaces, vertical height of the pyramid, equality of all the sloping edges of the pyramid and the relation between the distance between the foot of the perpendicular drawn from the vertex to the base and midpoint of the side of the base and length of the side of the base. In another school, solid materials needed in mensuration chapter were kept. I demonstrated solid pyramid made of the wood and described about its different dimensions and surfaces. I felt that the students were not as confused as in the formal school. They paid more interest to observe the solid and listened to me. I measured the length of the square base and slant height of the pyramid and told them to find its total surface area. All the students were busy to calculate it and most of the students calculated it correctly. I drew a prism on a board, wrote the measurement equal to the measurement of the prism demonstrated and said that it is the figure of the demonstrated pyramid. I drew another prism on the board, wrote the measurement of length of base and slant height and told them to find its total surface area. I found that most of the students found its surface area correctly."

According to cognitive information processing model of learning process, we receive information through our senses and some of the information is stored in working memory (Bourne et.al, 1986; Ormrod, 2004, as cited in Johana, 2009). Once information is in working memory, it can be encoded and transferred to long term memory. When using manipulative materials in mathematics classroom, students

receive information through several senses, such as visual and tactile senses, but this information stays in the sensory memory for a very short period of time. To maintain information and move it to working memory, it is necessary to pay attention to it. We have limited capacity of attention so we select some of the sensory information to pay attention to the process (Ormrod, 2004 as cited in Johana, 2009). Attention is influenced by different stimuli such as size, unusualness, intensity and personal significance. Using manipulative materials in mathematics classroom may help students pay attention to the information that can be abstracted from the objects. After the information is gathered in sensory memory, it is then moved to working memory. Two strategies are suggested to hold information in working memory, repeating aloud to help keep auditory information, which activates the phonological loop, and using visuals to maintain information, which is the same as activating the visuospatial sketchpad (Ormrod, 2004, as cited in Johana, 2009). Using manipulative material, students may activate the visuospatial sketchpad through the visual representation of these tools.

Information in working memory needs to be moved to long term memory for learning to occur. We encode information from working memory to transfer it, encoding the information in different ways such as making it meaningful, organizing it, visualizing it, elaborating something from it, or rehearing it (Ormrod, 2004, as cited in Johana, 2009). Students, working with manipulative materials could also make mathematical content meaningful by connecting it with their experiences of using manipulative materials. Students also code information in a visual way. Students using manipulative materials can see a visual representation of the abstract content helping students make connections between content and such representation.

Regarding the benefit of using concrete materials in mathematics classroom, T6 said,

> *"I feel different teaching using materials and without using them. I use materials in mensuration chapter. We have some solids (cylinder, cone, prism, pyramid) kept in our school. While using cylinder, cone, prism, and pyramid in classroom, I do not need to speak more. Concrete materials themselves speak. I do not need to speak loudly. Every student observes carefully and listens attentively. Students are curious to know about it. In other chapters, where I do not use materials, I have to speak and write more. If students are taught using real object, about what they are learning, they will get practical knowledge and their concept will be clear. They can solve the related problems themselves. The teacher does not need to solve varieties of problems."*

Many students need hands-on approach to generate interest and comprehend what's taking place (Posamentier & Krulik, 2012). Concrete materials can be used to build interest and help students gain an understanding of the concept. Students using concrete materials have opportunities to learn via senses of touch and sight providing students a strong foundation for understanding a concept (Sheman & Richardson, 1995). When students gain an understanding of the concept, they can solve different types of problems themselves and teachers do not need to solve varieties of problems.

It's very unlikely that students will sit for an hour and listen to the teacher talks and become intrinsically motivated to learn. They need concrete materials and are allowed to take their learning to another level. Student taking a hands-on approach in the classroom is so important for making connection and for motivating them (Posamentier & Krulik, 2012). Concrete materials used in mathematics classroom

motivate students toward learning because lessons including concrete materials are fun and engage students in class activities that involve work with the tool (Moyer, 2001).

Challenge of Using Materials

Though the use of concrete materials in mathematics classroom is highly beneficial, it has been found that many teachers are not using them in their instruction. Some teachers do not use concrete materials in their instruction at all whereas some teachers use only in some chapters. Definitely there are different factors which impede teachers to use concrete materials in their instruction. Some of the factors that affect teachers to use concrete materials in their instruction are: teachers' knowledge about the tools, classroom management, availability of materials, time, management of materials, and cost of them (Gilbert & Bush, 1998; Sherman & Richardson, 1995).

Teacher competence or knowledge is another factor of using manipulative materials. Gilbert & Bush (1998) report that this is not as important as lack of time needed to use these materials. Lack of time is considered to be an important factor because some teachers understand that activities involving manipulatives require more time (Sherman & Richardson, 1995). Classroom management is another factor as teachers reported that manipulative work is viewed as a strategy where students could get out of control because they may get overly enthusiastic working with manipulative (Sherman & Richardson, 1995). When students are using manipulative in their classroom they would talk much more in mathematics classes with their peers in small groups as well as in whole class discussion (Cohen & Ball, 1990). In addition, some teachers avoid using manipulatives because parents and others at the school believe that the manipulative are the games and are counterproductive to teaching (Sherman & Richardson, 1995).

Evaluation system is another impediment of using concrete material in mathematical classroom. Effective use of concrete materials helps to develop concept and to understand mathematical idea. Paper pencil test to calculate correct solution to mathematical problem cannot evaluate students' understanding level. Concept development and understanding should be valued highly. Evaluation of students' mathematics should be changed from tests to assessment. For teachers to know students' understanding of concepts, different techniques of evaluation are needed. Teachers can know students' mathematical understanding by: 1.listening to students' talk about their mathematical thinking 2.observing students working individually and in cooperative groups, 3. asking why and how questions rather than asking yes or no question, for results of calculating activities, for answer and 4. Having students write a solution to a problem rather than by only responding correct or incorrect values.

Regarding the challenges of using materials in mathematics instruction, T_1 said,

> *"Few years ago, I taught students using concrete materials as far as possible. I tried to help students to conceptualize mathematical ideas involving them in different activities and established different formula using concrete materials. Students enjoyed and concentrated on different activities, school administrator and some parents appreciate me for the work. Due to the limited time, I could not discuss different types of problems with the students. Due to the lack of procedure knowledge, students could not score high in examination. I could not be a good teacher for marks oriented school administration and some guardians. I was discouraged to use materials and to make students participate in different activities using materials but encouraged to be marks*

oriented by solving more problems and telling students to solve other more problems by using the same procedure."

Effective use of manipulative materials in mathematics teaching contributes to conceptualization and understanding rather than drill and practice of rote procedure (Heddens, 1997). Our evaluation system examines problem solving procedure and correct calculation of problems. Due to the limited time period for a subject, students taught using manipulatives frequently, gets less opportunity to develop procedure skill of problem solving by observing and discussing on the solution to the problems solved by the teacher and hence students cannot perform well in an examination. Lack of time is a factor of not using manipulative materials in mathematics classroom because activities involving manipulatives require more time (Sherman & Richardson, 1995). If mathematics is taught using manipulative materials, then the methods of evaluating mathematical achievement must also change. Just calculating correct solutions to mathematical problems is not sufficient. Concept development and understanding should be valued more highly (Heddens, 1997). Many guardians believe the marks obtained by students in an examination as the quality of the school. Similarly, many school administrators also compare the quality of teacher to the marks obtained by the students in their subject. So, to be established as a so called good teacher, teachers avoid using concrete materials in their instruction. Some parents and administrators of the school believe that manipulative are games. They feel use of materials is the waste of time and they prefer to teach in traditional way as they have learned. Teachers avoid using manipulative materials because parents and others at the school believe that manipulatives are games and are counterproductive to teaching (Sherman & Richardson, 1995).

Regarding the challenges of using concrete materials in mathematics classroom, T2 said,

> *"Most of the teachers are not trained and they do not have in-depth knowledge about the preparation and use of materials in mathematics teaching. Due to the lack of in-depth knowledge neither they can manage nor can they use it properly in the classroom. Students may understand in another way as teacher wants to show mathematical ideas or students will not see any mathematical ideas and feel the use of material as a game. Due to the lack of knowledge, teachers cannot manage the classroom and students would be out of control."*

Manipulatives by themselves cannot bring about understanding (Viadero, 2007). The importance of using manipulatives is the quality of students' thinking promoted by using them as well as abstractions that can be reached from the interaction with these objects (Kohler, 2008). How teachers design their classroom activities involving manipulative will ultimately affect the success of their use on student understanding. Students need to have a clearly established criterion for effectively handling and using manipulatives in the classroom. Without a clear set of expectations, students may misuse and teachers will become frustrated and disillusioned about manipulative use and most likely, discontinue their use in the classroom (Kelly, 2006). For this, teachers should be competent about manipulatives and their use. Classroom management is another factor of not using manipulative by the teacher. Manipulative work is viewed as a strategy where students could get out of control because they may get overly enthusiastic working with manipulative (Sherman & Richardsion, 1995). When students are using manipulative in their classroom they would talk much more in mathematics class with their peers in small

groups as well as in the whole class discussion (Cohen et al., 1990). In this regard, T3 said,

> *"Using concrete materials in mathematics classroom, students can understand in an easy way. They can solve practical problems, classroom will be more interesting but it cannot be applied frequently due to various reasons. First, to manage it, teacher needs to provide extra time but mathematics teacher are busy and cannot provide extra time for it. Second, to use materials in the classroom, it takes more time and the course cannot be completed on time but we need to complete the course on time. Third, students cannot perform well in an examination without practicing different types of problems. To make students practice, teacher needs to discuss about different problems by solving them. Bright students can solve themselves with the help of worked out examples but poor students cannot."*

Systematic use of materials is very difficult for a teacher then administrating a program (Post, 1981). Students need to have a clearly established criterion for effectively handling and using manipulative in the classroom. Without a clear set of expectations, students may misuse (Kelly, 2006). It needs a lot of preparation on the part of the teacher. Preparation is needed to manage any type of activities in the classroom (Upadhaya, 2007). For preparation the teacher needs to provide extra time but all teachers cannot provide extra time being busy. Activities involving manipulative require more time (Sherman & Richardson, 1995). So, to use materials in mathematics classroom, it needs more time. If manipulative materials are used in the classroom the scheduled course cannot be completed on time. Bright students, who have understood the mathematical concept, can get the procedure knowledge of solving problems with the help of worked out examples but for below average

students, teachers need to support them to get the procedure knowledge of solving problems by discussing on the solutions to different types of problems. Science activities involving manipulatives require more time and teachers cannot provide enough time to discuss different types of problems, the below average students cannot perform well in an examination and hence the teachers avoid the use of manipulative. In this regard, T4 said,

> *"I have some knowledge about concrete materials used in mathematics instruction and I use materials in my classroom. Using concrete materials in classroom, I take more time to complete the course. Another math teacher in my school does not use the materials in his instruction and completes the course earlier. Then he revises the course. School does not manage extra time for me for the revision and I cannot revise all the courses. In an examination, students taught by another teacher score higher than the students taught by me. School does not provide any incentives for me so that I continue their use in my instruction. Instead low performance in an examination creates pressure from school administrator and guardians."*

T_4 uses concrete materials in his instruction and cannot complete the course on time. He does not revise the course and students do not perform well in the examination. Effective use of manipulative contributes to conceptualization and understanding. Using manipulative may make the instructional period longer initially, but students retain the knowledge better and will required less review time later (Schweyer, 2000). Moreover, the low performance of the students may be due to the quality of the questions. Questions asked in an examination may not be at the level that students understand from the manipulatives and students could not perform well in the examination. T_4 further said that,

"There is no practical mark in mathematics. Lack of practical problems in an examination discourages to use concrete materials in their instruction."

Using manipulative materials in teaching mathematics will help students learn to relate real world situation to mathematics symbolism (Heddens, 1997). Like in Science and Computer if some marks were allocated for practical examination and if practical or real world problems were given to solve in practical examination, teachers would use manipulative materials in their classroom. So due to the lack of practical problems in the set of questions asked in the examination, teachers are not encouraged to use manipulatives in their instruction. In this regard, T_5 said,

"Due to lack of time, financial problem and traditional way of teaching, teachers do not use materials frequently. Mathematics course is lengthy and many problems are in the text books. If materials are used frequently the course cannot be completed in time. Students are habituated to learn by traditional method to be quiet in the classroom, copy down formula, and remember the formula and apply them to solve problems. If they are taught using materials, they feel that they are playing a game but not learning."

It is true that activities involving manipulative require more time and mathematics is lengthy course. There are many chapters in the course. It takes more time to conceptualize all the chapters using materials. There are many problems in the book. If materials are used frequently, time will be insufficient to discuss different problems. In my experience, many teachers follow traditional method of teaching due to time constraints. Another reason is that they believe that mathematics classroom should be silent. Therefore, they explain or solve problems and students listen to the teacher or observe the solutions solved by the teachers. Students solve other problems following the process as the teacher did. Those students view materials as toys or

playing thing rather than as tools to work with to better understand mathematics. In this regard, T_6 said,

> *"Many teachers are not from educational background. They have not taken any training related to teaching methodologies. So, many teachers do not have good knowledge about the materials used in teaching mathematics. I think lack of knowledge is one of the challenges to use materials in mathematics instruction. Next, in many government schools, there are more number of students. It is very difficult to manage the classroom if materials are used in the classroom."*

Systematic use of materials is more difficult for the teacher then administrating a program designed around text and workbooks (Post, 1981). Many teachers of schools do not have sufficient knowledge about the use of materials in their instruction. Neither they have experience of learning using materials in school nor have they taken any training about it. Due to the lack of sufficient knowledge, teachers cannot exhibit the mathematical ideas in using materials. A manipulative material holds the potential of harm if they are used poorly (Heddens, 1997).

Chapter Summary

In this chapter, I have presented the benefits and challenges of using materials as explained by the mathematics teachers. Mathematics teachers explain the benefits of using materials as they help understand abstract mathematical ideas. They make the lessons fun and engage students in class activities. Using manipulative materials students do not need to learn mathematical formula in a rote manner. They can derive and learn it meaningfully using manipulatives. Concrete materials used in mathematics classroom build interest in students towards mathematics. Students taught using concrete materials can solve real life problems. Mathematics teachers

explain challenges of using materials as lack of teachers' knowledge about the materials, lack of enough time to use them in the classroom, belief of school administrator and guardians about the materials, lengthy course, more problems in the text book, more number of students in a classroom, unavailability of materials and their cost are the other impediments to use materials in the classroom.

CHAPTER VII

REFLECTION, FINDINGS AND CONCLUSION

Chapter Overview

This chapter includes the conclusion of my study. It also includes my reflection upon selection of this topic and collection of data. This chapter also includes some suggestions for educational leader, curriculum designers and educational policy and program makers on the basis of the findings of my study.

My Reflection and Conclusion

When I selected the topic for my research study, I had no idea about the research and many questions arose in my mind. I remembered that the way of teaching geometry by our teacher using bamboo sticks to build our concept related to congruent triangles. I also remembered that I had used solids (cone and cylinder) to make students understand that the surfaces of a solid formed by attaching cone and cylinder are circle, curved surface of cylinder and curved surface of the cone. Again I remembered that most of the mathematics teachers are not using materials in their instruction to make poor student understand. Such scenario raised many questions in my mind about teachers' belief and practice towards materials. Those questions were my initial research questions. But later with the help of my dissertation supervisor, I modified my research questions so that they could exactly address my problem.

To get the answers to my questions, I had gone though some dissertations which were available in our libraries. I browsed websites of different universities, dissertation database, documents, articles and books. But I did not get answers to my

research problems in the context of Nepalese teachers. Going though the dissertations conducted in other countries, I found some incomplete answer to my research question in the context of foreign teachers. So I realized that I needed to conduct the research to get the answer to my research questions.

I prepared some interview guidelines and went to the field. With the help of interview guidelines, I collected data which recorded on a recorder. The recorded data were transcribed. After analyzing the data of the first participant, I realized the data were not sufficient to answer my research question. I modified the interview guidelines and went to other participants for interview. I again interviewed the first participant with modified interview guidelines. I observed classes of each participant to know their practice of material.

Analyzing the data from all participants, I identified the common themes. While analyzing the data I felt that responses to my questions from some participants were not sufficient to answer my research question. So I again went to them for interview. On the basis of the data I would like to conclude my study with the answers to my research question.

Q.1. what perceptions do mathematics teachers hold on using materials in their instruction?

According to Oxford Dictionary, perception is an idea, a belief or an image one has as a result of how she/he sees or understands something.

This study covers a board area of belief of mathematics teachers towards materials. I could not do as I had wished as there were many obstacles. I tried to answer the question under the following views of participants towards materials: tools to understand mathematical concept, tools for motivation and tools to teach in an interesting way.

Tools to Understand Mathematical Concept

Studying the literature related to my research study and interacting with the participants, I came to know that material helps students to understand mathematical concept/ ideas/ relation. Students using materials have opportunities to learn via senses of touch and sight providing students a strong foundation for understanding a concept. Materials allow students to see and feel concepts in a concrete way.

Materials help to connect mathematics with real world experience and they help enhance memory and understanding because of the physical movements required while using these tools.

Tools for Motivation

The study shows that teachers perceive materials as tools for motivating students towards learning. Lessons including materials engage students in class activities and fun. When materials are used students who are not motivated towards study also observe materials, investigate mathematical ideas in materials, share the ideas with friends, question their friends and teacher and gradually get motivate towards learning.

Students, who cannot understand abstract mathematical ideas, can also visualize the ideas in materials and then feel proud. They share their findings with their friends. They apply the ideas got in materials to solve the text book problems. This increases their confidence and be more encouraged. Gradually they feel motivated towards learning.

Tools to Teach in an Interesting Way

The study shows that teachers use materials in their class to make the classroom interesting. They believe that in mathematics class, students have to listen to the teacher silently, remember rules, procedures and algorithms applied in the

problems solved by teacher and use the same rules, procedures and algorithms to solve all the text book based problems. If materials are used, students engage in different activities. They can share their ideas to each other. Doing this, they feel the class is more interesting.

2. In what way do mathematics teachers use materials in their instruction?

I would like to answer the question under the following themes.

Preparation of Materials

Most of the teachers prepare materials they use by themselves or supervise students to prepare it. Some materials they buy from the market. Some teachers do not prepare on their own though they have very good knowledge to prepare it due to being busier. Neither they give ideas to students to prepare nor do they buy it.

Storage of Materials

Most of the teachers were found to keep the materials in the staff room. Some teachers have kept in the library and in coordinator's room. The common materials kept by teacher are some solids like pyramid, cone, cylinder, graph chart, geo-board and geometric instruments. Some teachers have kept clinometers, trigonometric ratio measuring instrument, reflection and rotating demonstrating materials, pre chart, bar graph, a set of cubes and cuboids for the demonstration of $(a+b)^3=a^3+3a^2+3ab^2+b^3$ marbles, birthday cap, two dimensional shapes like quadrilateral, rectangle, square, parallelogram, rhombus, trapezium, circle, different types of triangles, pentagon, hexagon material for demonstration of $(a+b)^2=a^2+2ab+b^2$ and factorization of trinomial algebraic expressions and some electricity and telephone bills.

Methods of Using Materials

Mostly teachers use materials in the beginning of the chapter to develop concepts in the students about the related chapter and sometimes they use during

problem solving to solve problem linking with the materials. Teachers demonstrate the materials and instruct student activities to explore mathematical ideas and to establish mathematical formula.

From the observation and interviews, I have found that mostly teachers do not give materials to students to observe or play with them. They just show the students using materials however, they know that "students need material to manipulate independently and that demonstration by a teacher or student is not sufficient" (Heddens, 1997).

Use of Materials

Some teachers use materials in most of the chapters at the beginning. Some teachers use only in few chapters but some teachers do not use materials though they are trained. They do not use materials due to the pressure to complete the course earlier. Teacher uses less material in class 10 in comparison to other classes to complete the course earlier, besides they are being more result oriented.

Q.3. How do teacher explain challenges and benefits of using materials in mathematics classroom?

From the study, I understood that one of the challenges to use material is the evaluate system. Effective use of materials contributes to conceptualization and understanding. Our evaluation system does not understand conceptualization and understanding. It examines only problem solving skills using paper and pencil. "If mathematics is taught using manipulative materials, then the method of evaluating mathematical achievement must also change. Just calculating correct solution to mathematics problems is not sufficient. Concept development and understanding should be valued more highly" (Heddens, 1997). For teachers to assess students'

understanding of concepts, different techniques of evaluation will be needed (Heddens, 1997).

Next obstacle to use materials is school administrators who are unknown of different teaching methodologies. Conceptualization using materials may not produce good result in examination to get only correct answer to the problem. So the result oriented administrators may not feel good about teaching using materials.

Third, text book based on traditional way of teaching where students have to remember rules, procedure and algorithms and use them to solve problems having many problems of the same types so that student cannot be engaged in activities using materials are also obstacles to use materials in the classroom.

Fourth, guardians' belief that use of materials is a waste of time is also an obstacle to teach using materials. Many parents still prefer traditional method of teaching.

Fifth, teacher knowledge or competence is another obstacle to teach using materials. Most of the teachers are untrained and are from non education background. They may not have knowledge to prepare and use materials properly. Improper use of materials convince students that two mathematical world exist one mathematics in material and next mathematics of symbol (text book mathematics).

From the study I understood that materials help students to understand mathematical ideas easily, to make classroom interesting, to reduce students' math anxiety and to motivate students towards learning. Abstract mathematical ideas, which students cannot understand, can be represented through materials. Mc Neil and Jarvin (2007) state manipulative helps to connect mathematics with real world experience and it helps memory and understanding because of the physical movements required while using these tools.

Suydam (1984) also indicated that teachers believe manipulatives to be tools that could help student develop meaning in mathematics. Uses of materials in class are fun and engage students in activities which make classroom interesting and motivate students towards learning as Suydam (1984) states, manipulative motivate students because lessons including manipulative are fun and engage students in class activities that involve work with these tools.

Educational Implication of the Study

From the experience of this research study, I inferred that materials play a great role in teaching mathematics. Proper use of materials help students learn to relate real world situation to mathematics symbolism. Their proper use helps student rise to understand mathematical ideas/ concept/ relations interest and motivate students towards learning mathematics. But improper use of materials convince student that two mathematics world exist mathematic in material and symbolic. Though materials play a great positive role in mathematic classroom however due to evaluation system, text book based on traditional way of teaching having many problems of the same type, school administrators who are unknown of the latest teaching methodology, guardians who prefer traditional way of teaching, and lack of sufficient knowledge of teaching about material not all mathematics teachers are using materials.

Thus, there should be change in the method of evaluating mathematical achievement. Just calculating correct solutions to mathematical problem is not sufficient. Concept development and understanding should be valued highly. Different techniques of evaluation should be applied.

Regarding textbook activities, problems based on real life situations should be included in the textbook. Similarly, why and how question rather than calculation of

correct answer oriented question should be included. Instead of many problems of the same type, in which student practice for procedure and calculation of correct answer verities of question should be included.

School administrators should know about different methods of teaching. They should understand that mathematical achievement is not only to calculate correct answer to the problem. Training should be provided for administrators so that they would not be against different methods of teaching and against noise in classroom. Strict rules should be implemented about school administrators that they should be from educational background. Guardians should also be convinced about different methods of teaching so that they will not feel use of material as a waste of time and money.

Teachers are the persons who directly interact with the students and implement different methods and techniques for effecting teaching. If they do not have knowledge about teaching methodologies, they cannot teach effectively. So teachers should be trained properly. Government should make a policy so that only trained persons can be teacher.

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