EFFECTIVENESS OF MANIPULATIVE MATERIALS IN TEACHIMG MATHEMATICS

A

THESIS

BY

RAMESH PRASAD JAISI

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER'S IN MATHEMATICS EDUCATION

SUBMITTED

TO

DEPARTMENT OF MATHEMATICS EDUCATION

CENTRAL DEPARTMENT OF EDUCATION

UNIVERSITY CAMPUS KATHMANDU

TRIBHUVAN UNIVERSITY,

KIRTIPUR, NEPAL

2020

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LETTER OF CERTIFICATE

This is to certify that Mr. Ramesh Prasad Jaisi, a student of academic year 2070/071 with (Campus Roll No.106/071,) thesis No. 1392, Exam Roll no. 280500/071 and T.U registration No. 9-2-676-86-2009 has completed his thesis under my supervision during the period prescribed by the rules and regulation of Tribhuvan University, Nepal. This thesis entitled **"Effectiveness of Manipulative Materials in Teaching Mathematics"** has been prepared based on the results of his investigation. I hereby recommend and forward that his thesis be submitted for the evaluation as the partial requirements to award the degree of Master of Education.

.....
Prof. Dr. Bed Raj Acharya
(Head of Department)

Date: 14 August, 2020
30 Shrawan, 2077

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LETTER OF APPROVAL

Thesis Submitted

By

Ramesh Prasad Jaisi

Entitled

"EFFECTIVENESS OF MANIPULATIVE MATERIALS IN TEACHING MATHEMATICS"

Has been approved in partial fulfillment of the requirements for the degree of Master of Education

Committee for Viva- voce	**Signature**
1. Prof. Dr Bed Raj Acharya (Chairman)	……
2. Prof. Uma Nath Pandey (External)	……
3. Mr. Krishna Prashad Bhatt (Member)	……

Date: 14 August, 2020

30 Shrawan, 2077

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RECOMMENDATION FOR ACCEPTANCE

This is to certify that Mr. Ramesh Prasad Jaisi has completed his M. Ed. Thesis entitled **"Effectiveness Of Manipulative Materials In Teaching Mathematics"** under my supervision during the period prescribed by the rules and regulations of Tribhuvan University, Kirtipur, Kathmendu, Nepal. I recommend and forward his thesis to the Department of Mathematics Education to organize final viva-voice.

.....
(Mr. Krishna Prashad Bhatt)
Supervisor

Date: 14 August, 2020
30 Shrawan, 2077

DECLERATION

The thesis contains no material which has been accepted for the award of another degree in any institutions. To the best of my knowledge and belief, this thesis contains no material previously published by any authors except due acknowledgement has been made.

…….

Ramesh Prasad Jaisi

Date: 14 August, 2020

30 Shrawan, 2077

Defense Date: 14 August, 2020

DEDICATION

To my parents:

Mr Maniram Jaisi and Dhana Jaisi

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to my research supervisor Mr. Krishna Prashad Bhatt, Department of Mathematics Education, Tribhuvan University, Kritipur, Kathmandu, is my honorable teacher helped me extremely by providing his valuable time for all sorts of ideas, techniques and information during the research work from the beginning to ending. His enthusiasm, patience, kindness and generosity are over memorable.

I would also like to thank Prof. Dr. Bed Raj Acharya, Head Department of Mathematics Education, Tribhuvan University, Kritipur, for his valuable suggestion to accomplish this research work.

Furthermore, I am very much thankful to Prof. Uma Nath Pandey for his invaluable suggestion to form this research more academic.

I am equally thankful to Prof. Dr. Eka Ratna Acharya and Prof. Abatar Subedi for valuable comments and suggestions to bring this research work in the present form.

I am also very much indebted to all students of the experimental and control group for their active participation, and the teacher of mathematics and principles of the schools where I completed my research.

Lastly, I wish to thank my family for their support and encouragement up to the minute.

…….

Ramesh Prasad Jaisi

ABSTRACT

This is a study on "Effectiveness of manipulative materials in mathematics teaching." The primary purpose of the study was to compare the achievement of grade VIII student in maths taught by using and without using manipulative materials and to explore the feelings of students and their activities in class while by using manipulative materials. For achieving this purpose, the researcher used an experimental research design in which researcher adapted the pre- test post-test non-equivalent group design.Two private schools were selected by randomization in Kathmandu district. After twenty days of regular treatment to the experimental group, achievement of students were recorded in terms of post-test. The internal consistency of each test was ensured by calculating Cornbrash's Alpha model with SPSS 21.0 setting 0.05 level of significance. From the result, the study has succinctly shown that there was a significant difference in students' achievement of experimental and control group in post-test. Achievement tests and teaching episodes were the main tools for the study and mean, standard deviation and t-test (at 0.05 level of significance) were used as statistical tools and analyze qualitative data by students' motivation and participation in the activities. After analyzed the obtained data, it was concluded that the usage of manipulative materials is more effective than the conventional problem solving strategy in mathematics.

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ACRONYMS

CDC = Curriculum Development Center

CRA = Concrete Representational Abstract

GON = Government of Nepal

LD = Learning Disabilities

MD = Mental Disabilities

NASA = National Assessment of Students Achievement

SD = Standard Deviation

SPSS = Statistical Package for Social Science

Chapter I

INTRODUCTION

This was the research thesis entitled "Effectiveness of Manipulative Materials in Teaching Mathematics." This was the first chapter, which consists of background of the study, statement of the problem, objectives of the study, research questions and significance of the study, hypothesis of the study, delimitations of the study and operational definitions of the key terms.

Background of the study

Mathematics is a gateway to different fields of higher education. In order to make meaningful mathematics teaching and effective to learn in the classroom, the student should be interested and attracted to learn mathematics and they should also find its usefulness and application to their real life situations so various methods of mathematics teaching have been devised to achieve this goal. To such a new concept, the teacher most decide what subject matter will help in achieving the aim of study, and then select the proper method for teaching the concept. Mathematics is interpreted, explained, used in different ways or situation of human life. It helps to generate, logical, intuition, constructivism, analysis, formulation, generalization of judgment power.

Algebra teaching is the all-important part in mathematics teaching at the school level because of its vertical and horizontal relationship with the higher level of education and other contents of mathematics. However, in many schools, algebra is taught at the periphery of the traditional approach in which there is no connection between algebra and geometry. In order to improve students' score in mathematics, many schools and hence mathematics teachers have introduced various technology in geometry but not in algebra. Even though, many teachers lack the knowledge of how

to properly incorporate technology in the classroom (Doering, Huffman, & Hughes, 2003) to connect various branches of mathematics. So, there has not a fruitful connection between algebra and geometry that hinged on the overall performance of students in mathematics.

Manipulative materials are tools that make learning new mathematical skills a hands-on process. Swan and Marshall (2010) have developed the following definition of manipulative: "A mathematics manipulative materials is an object that can be handled by an individual in a sensory manner during which conscious and unconscious mathematical thinking will be fostered" (p 14). This definition includes materials designed specifically for use in the math classroom such as Base Ten Blocks and Algebra Tiles, but it is also flexible enough to incorporate creative mathematical uses of common objects such as Popsicle sticks, beads, and dice (Ojose, 2008).

Manipulative materials are concrete materials such as geo-boards, pattern blocks, chip-trading boards, counters, circle board, algebra tiles, tan gram, attribute pieces, fraction bars and Cuisenaire rods that students arrange in some way to represent a variety of mathematical relationships. Common instructional materials include chalkboards, charts, graphs, diagrams, flat pictures, photographs, maps, models objects, motion pictures, textbooks, reference books, computers etc. Yet, teaching with manipulative materials, especially with the newer technologies that suit today's information technological society is the trend in contemporary society. It is suggest that manipulative materials can be used an intermediary between the real world and mathematical world. Moreover, the use of manipulative materials as a concrete models be more abstract that the factual situations but less abstract than formal symbols. Manipulative materials helps student to:

- relate real world situation to mathematical symbolism in different ways,
- work together co-operatively in solving problem,
- discuss about mathematical idea and concept,
- verbalize their mathematical thing,
- Make presentation in front of a large group there are many different ways to solve problems, and solve the mathematical problems with minimal guidance from teachers.

Algebra tiles are new and concrete materials to teach algebra. Algebra tiles are geometric model that explore algebraic concepts. Algebra tiles have a variety of other names; Algebra tiles, Math tiles, virtual tiles. Algebra tiles can help students to visualize equivalent algebraic expression or equation. Many of the tiles have the positive and negative side. The virtual algebra tiles activities will use multi-colored positive tiles. The reverse side of each tile is black. It helps to understand that tiles have one positive and one negative dimension. The tiles are made from colored card, wood, stone etc. Recently many of the commercial versions of algebra tiles are made from plastic and possess a projectile quality.

Statement of the problem

Mathematics is one of the important disciplines with broader application in all over the world. This research is mainly concerned with the impact of manipulative materials in teaching algebra mathematics at class VIII. In Nepalese context, generally teacher are using their own conventional methods and students do not get chance to construct their own knowledge. Most of the school of Nepal is still using the traditional methods characterized by mastery of subject matter, through drill, repetition and memorization. In order to make the mathematics teaching practical and life oriented the teacher is expected to follow learning by doing, learning by practical

working and he should also use the manipulative materials properly. This study is mainly concerned on investigating the answer of following research question.

1 Does the manipulative materials yield better achievement of students than without using manipulative materials?

2 How do students feel towards the use of manipulative materials in teaching mathematics?

Objective of the study

The main objectives of this study was to assert the usefulness of using manipulative materials on students' achievement at basic level mathematics. This study was also intended to accomplish the following objectives:

1. To compare the achievement of grade VIII student in maths taught by using and without using manipulative materials.
2. To explore the feelings of students and their activities in class while by using manipulative materials.

Justification of the study

This research would help to identify the effectiveness of manipulative materials in mathematics achievement of school level. It would help for the teachers, mathematics educators, curriculum planners and researcher to develop and use manipulative materials. It would be beneficial to the concerned person and agencies to choose the appropriate material and technique of teaching and improve their teaching strategy. The most significant contribution of this study would be the effectiveness of manipulative materials in teaching mathematics. This study would be significant as follows:

- To find out the effectiveness of manipulative materials in teaching algebra at basic level.

- To use manipulative material in classroom teaching through teaching experiment.
- This study would help the teachers, teacher trainers, teacher educators, curriculum designers, and textbooks writers, those who are interested in mathematics teaching at basic level.
- To improve the achievement of students in mathematics.

Hypothesis of the study

Hypothesis is the assumption or guess about the population involved. Such assumption that may or may not be true are called hypothesis. In conducting any research the next step after the selection of the problem is to formulate hypothesis. Hypothesis helps the researcher to find out the fact in scientific way and testable form. So researcher has set the following hypothesis.

(a) Research Hypothesis

Student who were taught by using manipulative materials achieve better score than those taught without using manipulative materials.

(b) Statistical hypothesis

The following statistical hypothesis was formulated;

$H_0: \mu_1 = \mu_2$ (Null hypothesis)

$H_1: \mu_1 \neq \mu_2$ (Alternative hypothesis)

Where μ_1 and μ_2 were mean achievement score of the students taught by using manipulative materials and without using manipulative materials respectively.

Delimitation of the study

Delamination refers to boundary of the research work. It specifies the research topic which is going to be studied. This study has the following delimitations.

- The study was limited on Kathmandu district.

- This was experimental research conducted at grade VIII regarding teaching algebra.
- This study was conducted on two groups of students namely control group and experimental group, taken from two private school of Kathmandu district.
- Some of the variable like age, level of teacher, social status, and classroom environment and teacher experiences were ignored.
- In this study researcher used achievement test, observation notes, interview and episodes were the tools for data collection.
- The analysis of the data followed quantitative as well as qualitative.

Definition of Related Terms

Terminology is the study of terms and their use. Terms are words, compound words or multi - word expressions that in specific contexts are given specific meanings. These may deviate from the meanings the same words have in other context and in everyday language. Some terminologies used in this research have been defined as below:

Effectiveness. In this research, effectiveness of the students is defined from two ways. Effectiveness from the point of cognitive view can be defined as the better achievement of the students. In the same way, effectiveness in this study from the non-cognitive point is active participation of the students, regular presence on discussion and teaching-learning activities, interest on teaching-learning activities, motivation towards teaching-learning activities, self-control, self-regulation, self-discipline of the students and the students' commitment towards academic task.

Manipulative Materials. Manipulative materials are objects or things that the students are able to feel, touch, handle, and move. In this study, manipulative materials especially refer to the different models of factor kids which are used in

teaching algebraic expressions. They are cardboard, geo-board, rubber band, piece of soap, pencil and materials available in daily life situation, etc.

Control Group. The group of students who were taught through traditional method of teaching.

Experimental Group. The students who are taught using manipulative materials were considered as experimental group in this study.

Secondary Level. A lower secondary school, often referred to as junior high school, is a school which provides lower secondary education, between the ages of 11 and 14 depending on location, after primary school and before secondary education.

Algebra tiles. Algebra tiles are known as mathematical manipulative that allows students to better understands ways of algebraic thinking and the concepts of algebra. These tiles have proven to provide concrete models for elementary school, middle school, high school and college level introductory algebra students.

Achievement. The achievement on this study was defined in terms of score obtained by the learner in mathematics which is prepared by the researcher.

Achievements score. The obtained score of the student on achievement test constructed by the researcher. (Numerical value of learning takes place in students.)

Conventional Strategy. Conventional method which was the traditional strategy using in class room teaching.

Chapter II

REVIEW OF RELATED LITERATURE

This chapter conveys the review of related literature, which is divided in to three section. The first section presents the review of Empirical Literature, the second section includes the Theoretical framework and final section contains the Conceptual Framework.

Empirical Literature

This part of review includes the data based findings of part researches related to the present study. While including such findings, one has to cite author and his/her research title including major objective/propose, area of study, and methods; and significant results of the research. Any result from case study, surveys, Masters, MPhil, PHD thesis, faculty research, NGOs and INGOs studies can be include in this section. Some of the researches are reviewed here to support the guidelines for use of instructional materials in teaching learning mathematics which are supported to full fill the objectives of this study.

Cooper (2012), conducted a literature review in "Using virtual manipulative with pre-service mathematics teachers to create representational model" written by Suydam and Higgins in 1977 reported that the results of twenty-three studies comparing achievement of students who learned using concrete materials and without using concrete material. The primary grades study yielded mixed results: Eleven studies reported that manipulative materials helps to improved performance, two studies reported decreased the performance, and 10 studies indicated there was no significant difference in performance. Conflicting research on the effectiveness of manipulative indicates that concrete learning is not the answer for every student in all situations. The challenge for the mathematics teacher is to evaluate the skills and

learning styles of the class and determine if manipulative can engage students in the curriculum in a way that deepens their understanding.

Witzel (2005), investigated a full-sized inclusive Pre-Algebra class taught by the regular classroom teacher in "Using CRA to teach algebra to students with math difficulties in inclusive setting". Twelve general education math teachers participated in the study. Each teacher taught two classes as part of the study; one class was taught with the CRA method, and the other was taught with abstract explicit instruction. For each teacher, one of the two classes was randomly assigned to be the CRA class. Every class contained students with and without learning disabilities.

Each pair of classes studied the same five topics from solving equations with variables on each side. All classes took exactly 50-minute class periods to learn the material. The CRA group proceeded through one day of concrete instruction, one day of pictorial instruction, and two days of abstract instruction for each of the five topics. The non-treatment group was taught with researched-based strategies through explicit instruction for each day of the unit. The students in the non-treatment group still received high quality instruction that was probably similar to a typical math class taught in middle and high schools.

Amatya (1978), conducted a researcher on “A study of the effectiveness of teaching learning with and without the use of instructional materials". With the aims to find out whether instruction materials are helpful to develop the mathematical concepts and to measure the difference in concept development among students in the experimental and control group VIII. Sixty students from Lalitpur nagger panchayat were selected by using systemic sampling and the experiment was conducted for four weeks duration. The t – test was applied to conclude that the mean difference at 0.05% Level of significance. The conclusion was that the performance of the student

taught with the use of instructional materials was significantly improved when compared with the performance of the students taught without the use of instructional materials.

Pandey (1985), conducted an experimental study entitled “Use of visual aids in teaching fraction development of teaching models for teaching fraction in grade VI” with the aim to develop teaching models for teaching fraction in grade VI selecting proper visual aids and to see how effective the prepared model was. A teaching model with visual aids and a plain verbal exposition model were prepared. Sixty students were selected randomly and teach 20 days regular class. Pre-test and post- test research designs were chosen and t-test was applied to conclude that the teaching made with visual aids was found to be more effective than the verbal method.

Kehkashan (1918), conducted the research entitled "student's perceptions about the symbols, letters and signs in Algebra and how do these affect their learning of algebra". This study has revealed that the students have many misconceptions in the use of symbols in algebra which have bearing of algebra. It appears that the problems encountered by the students appeared to have connection with their lack of conceptual knowledge and might have been result of teaching they experience in learning algebra at the secondary schooling level. Some of the findings also suggest that teachers appeared to have connection with their lack of conceptual knowledge and might have been result of teaching they experience in learning algebra at the secondary schooling level. Some of the finding also suggest that teachers appeared to have difficulties with their own content knowledge. Here one can also see that textbooks with their own content knowledge. Here one can also see that textbooks are also not presenting content in such as elaborate way that these cold have provided

sufficient room for students to develop their relational knowledge and conceptual understanding of algebra.

Moreover, this study investigates student's difficulty in translating word problems in algebraic and symbolic form. They usually follow phrase to phrase strategy in translating word problem from English to Urdu. This process of translating the word problem from English to their own language appears to have hindered in the correct use of symbols in Algebra that might help to develop symbol sense in both students and teachers. By the help of symbol sense they can use symbols properly: understand the nature of symbols in different situations, like, in functions, in variables and in relationships between algebraic representations. This study will contribute to future research on similar topics.

Sharma (2001), conducted a research on "A study on the availability and use of instructional materials in teaching mathematics of the primary school of Parbat district in Nepal''. In his research he aimed to investigate the primary level. For this research, 25 teaching primary level mathematic were interviewed. For collecting the data interview was the main tools for the study .For data analysis simple percentage, reporting was applied to conclude that the availability of the materials was not found very encouraging. The using material were meter-scale, compass, clock model and abacus etc.

Gautam (2005), conducted a study on" The effectiveness of instructional materials in teaching menstruation at secondary level", with the aim to find out the effectiveness of instructional materials in teaching menstruation at secondary level. Mathematics achievement of boys and girls in content of mensuration. He taught by using instructional materials for experimental and without instructional materials for control groups of tenth Grade. For fulfilment of his thesis, he purposively selected the

control group and experimental group for data analysis. He used mean score, standard deviations, and t-test. He concludes that the performance of the students taught with the use of instructional materials was significantly better than the students taught without the use of instructional materials.

Ghimire (2005), conducted the research entitled "A study on the effectiveness of teaching algebra by using models in lower secondary level". The objectives to explore the effectiveness of models in teaching algebra at lower secondary level. The study conducted pre-test and post-test equivalent group design. The investigator change order develops the test consisting of seventeen multiple – choice question and ten subjective item based on the prescribed textbook of mathematics and the final sample contained sixty student of grade eight. The mean , variance, and two – tailed t –test were used, as statistical tool for the mean achievement of the student taught by using models was significantly greater than mean score of the achievement of the student taught without using models.

Goracke M .A. (2009), conducted the research in "The Role of Manipulative in the Eighth Grade Mathematics Classroom''. In this action research study of eighth Grade mathematics, researcher use of manipulative and its impact on student attitude and understanding. Researcher discovered that overall, students enjoy using manipulative not necessarily for the benefit learning, because it is actively engages them in each lesson. He also found that students did perform better on exams when students were asked to solve problems using manipulative in place of formal presentations of situations. In the course of this investigation, researcher also uncovered that student attitude toward mathematics improved when greater manipulative use was infused into the lessons. Students felt more confident that they understood the material, which translated into a better attitude regarding math class.

As a result of this research, researcher plan to find ways to implement manipulative in my teaching on a more regular basis. He intend to create lessons with manipulative that will engage both hands and minds for the learners.

Shrestha (2011), conducted the research entitled "effectiveness of instructional materials in teaching trigonometry at secondary level." which was aimed to find the effectiveness of teaching materials in teaching trigonometry secondary level. For the study researcher has followed experimental research by selecting two government schools of Sindhupalchok district using purposive sampling in each of the sample schools. For experimental period researcher applied experimental group with teaching materials and the control group were without materials. After sixteen days, post-test was administrating as the main tools for the collection of data. The pre-test and post-tests score of the student were tabulated and analysed by using statistical formulas T-test and f – test. Finally the research has found that the use of instructional materials are more effective for teaching trigonometric at secondary level.

Chaundary (2011), conducted a research on the topic "Effectiveness of instructional materials on teaching menstruation at secondary level." The researcher was amid to find out the effectiveness of instructional materials on teaching menstruation and to compare the student achievement by teaching with and without materials. The design of the study was pre-test post-test equivalent group design. In order to fulfil these objectives the researcher selected one school randomly in Siraha district. From the school, 44 students from grade x were selected for sample of the Study. The experimental and control group was determined by tossing coin. His experiment was run during of 15 days and test was conducted before and after the experiment. For data analysis researcher used t –test, which was at 0.05 level of

significance. Finally, the researcher conclude that the achievement of student in experimental group was better than the achievement of control group.

From, the above review of the related literature, it seems clear that mathematics education studies could not give a certain solution to overcome all the difficulties of learning and teaching algebra. Many of the work have been considered to address difficulties in teaching while others focusing on improving students' achievement. However, there are a few numbers of research that emphasis uses of instructional materials on teaching algebra. There is still gap that how use of manipulative materials helps to increase their performance in achievement test.

Theoretical framework

This study was based on constructivism approach to concept learning of Mathematics. Constructivism is a learning theory found in psychology which explain how a learner might acquire knowledge and experience based on past and present state of knowledge and experience of an individual. Constructivism is not a specific pedagogy. There are two types of constructivism: cognitive constructivism and social Constructivism. Cohen, Manion and Morrison (2013) stated that both constructivism's shares some common characteristics such as the view that the knowledge is constructed through reflective abstraction, through learners' cognitive structures and processing, through active and participative learning, and through the recognition that learning is not fixed and inert, but is continually developing.

Piaget's theory of Constructivist learning has wide-ranging impact on learning theories and teaching methods in education and is an underlying theme of many education reform movements. Research support for constructivist teaching techniques has been mixed, with some research supporting these techniques and other research

contradicting those results. Jerome Bruner is a psychologist who focused much of his research on the cognitive development of children and how it relates to education. While he has made many contributions to the field of psychology, his greatest contributions have been in the educational field.

Initially, Bruner was interested in how the mind organized and categorized information. Because his early career focused on cognitive psychology, Piaget's theories played a large role in his initial studies. Over time, however, as he began to specialize more on learning, Vygotsky and his ideas on the Zone of Proximal Development and scaffolding came to be increasingly influential to Bruner's research (Smith, 2002). Each of Bruner's stages of representation said that the knowledge and information learned in the previous stage, or in other words, the stage before acts as scaffolding for the next stage. The theory has come to play a huge role in mathematics education, particularly with the encouraged use of manipulative.

Eventually, Bruner's stages of representation came to play a role in the development of the constructivist theory of learning as well (Culatta, 2012). While Bruner has influenced education greatly, it has been most noticeable in mathematical education. The theory is useful in teaching mathematics which is primarily conceptual, as it begins with a concrete representation and progresses to a more abstract one. Initially, the use of manipulative in the inactive stage is a great way to "hook" students, who may not be particularly interested in the topic.

Furthermore, Bruner's theory allows that the teachers to be able to engage all students in the learning process regardless of their cognitive level of the concept at the moment. While more advanced students may have a more well-developed symbolic system and can successfully be taught at the symbolic level, other students may need other representations of problems to grasp the material (Brahier, 2009, p. 54). In

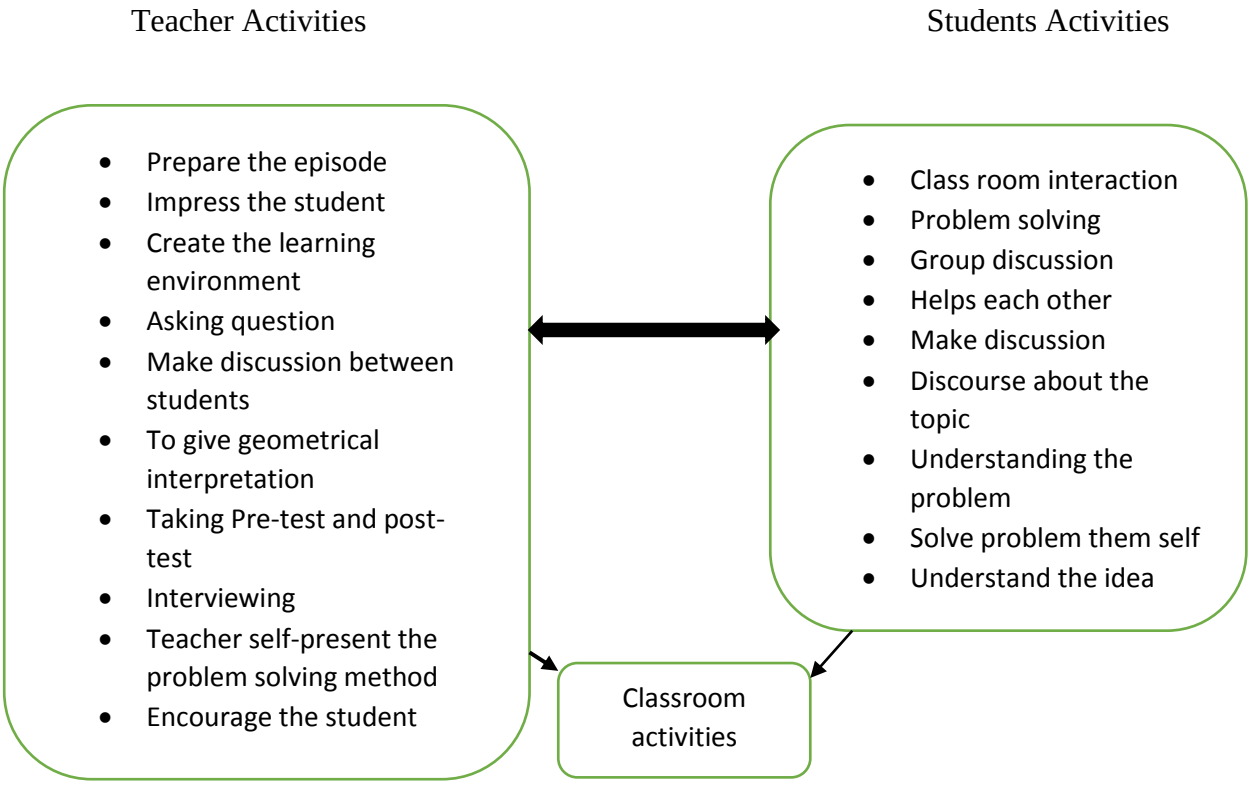
addition, by having all students go through each of the stages, it builds a foundation for which the student can fall back on if they forget or as they encounter increasingly difficult problems. For these reasons, it is essential that the teacher goes through each of the stages with the whole class; however, the time spent on each stage can and will vary depending on the student, topic.

Another important part of the theory's application is the academic language. The development and use of an academic language are crucial for successfully learning the concept. This primarily takes place in transitioning from the iconic stage to the abstract, language-based, symbolic stage. "Since language is our primary means of symbolizing the world, [Bruner] attaches great importance to language in determining cognitive development"(Mcleod, 2002). The correct academic language needs to be taught and used in the symbolic stage in order for the student to demonstrate that they can not only come up with the correct answer but that they understand the problem and process for getting it. In this context, the academic language involves not only vocabulary and mathematical terms but also mathematical symbols.

From this, it is concluded that learner constructs the meaning of mathematics based on individual cognitive development and symbolic language. In this study, teaching and learning Algebra with manipulative material is defined in terms of action, concepts, perceptions and reflection. The researcher has selected constructivism as theoretical grounds for this study because, by using the manipulative material students refine the algebraic thinking through geometric interpretation of each algebraic problems and solutions.

Conceptual framework

This study was based on constructivism learning theory regarding action, construction and reflection as the main concept. In algebra teaching and learning, student were taken as the central part of the learning however, manipulative materials and geometrical interpretation would also be placed in major part of the conceptual framework. The periphery of discussion in the algebraic contains, for example teacher give any question to the students then at first teacher create learning environment, make discussion between students, they make discussion to each other, helps to each other, share solving steps and idea, finally they get complete solution. This shows that manipulative materials make the connection of concept of algebra. For finalized the thesis I would derived the following process:



(Shahi, 2015**)**

In this frame there were the activity of teacher and students with the teaching materials algebraic tile. For the period of experiment researcher first prepare the teaching episode. Then researcher teaches in the classroom of experiment group by using the algebraic tile and make satisfaction in teaching learning activity by impressing the students. Researcher will ask different question about the topic and make discussion under the question, first researcher encourage the students to solve the problem themselves then researcher solve the problem himself by using the algebraic tile and provide the clearer concept about the topic .

For the student's activity and their motivation in class, they were motivate in learning and actively participate in the classroom activities. Researcher focus to the students for their group work and student help to each other for doing the class work. The students are encourage to solve the problem by using algebra tile.

Chapter III

RESEARCH METHODOLOGY

This chapter describe about the Research Design, Sample and population, Variables about the study, Data collection Tools, Data Collection Procedure and the way of Data analysis. Apart from this data section, this chapter includes ethical consideration throughout the research process.

Design of the study

Research design as a plan, structure and strategy of investigation to obtain answers to research questions and control variance. Additionally, a study design is the plan of action the researcher adopts for answering the research questions and it sets up the framework for study or is the blueprint of the researcher (Kerlinger, 1973). In this study the researcher had used pre-test post-test and non-equivalent group design for the purpose of the study which is presented in the following table.

Table 1. ***Pre-test post-test design***

Group	Pre-Test	Treatment	Post- test
ER	E1	Teaching with material	E2
CR	C1	Teaching without material	C2

ER- Experimental group CR- control group

E1- Pre -test of experimental group E2-Post -test of experimental group

C1-Pre- test control group C2-Post -test control group

Population of the Study

So far as the population of this study consists of the student in secondary level, class VIII in Kathmandu district. The study was conducted with two schools of

Kirtipur municipality, based on purposing sampling. However, the randomness was used for selecting them as experimental and control is supposed as 15 students.

Sample of the Study

For sample of the study, the researcher selected only two private schools of Kathmandu district. Both the schools were the sample of the study. Researcher selected two groups of students from Bagh Bhairab Boarding High school as experimental group and Kirti Secondary Boarding school for control group. The school were selected as experimental and control group by using purposive sampling technique.

First of all, pre-achievement test was taken to the whole students of grade VIII of both schools of students. Two groups were made homogenous as possible as on the basic of their pre-achievement scores. A fair coin had tossed to determine the experimental and control group. In this process, Bagh Bhairab Boarding high school were was selected as experimental group and Kriti secondary boarding school were selected as control group. Fifteen student were selected as experimental group and control group.

Variables of the Study

Prior to beginning of the experiment, the research might study the effect of variables. Variables are the conditions or characteristics that the researcher manipulative, controls or observed. The independent variables are the conditions or characteristics that the research manipulates or controls in his or her attempt to ascertain their relationship to observe their phenomena. The dependent variables are the conditions or characteristics that appear or change as the experimenter introduces, removes or changes independent variables .In this study, mainly two types of

variables are used which were dependent and independent variables. Some independent variables have been presented below:

Independent Variables, Controlled in the Experiment

Different extraneous variables can affect the validity of the research activity. This was the reason to control some variables such as maturation, history, time interval, testing effect and statistical mortality through this design of experiment. And other different variables were controlled by the following ways.

Teacher Variable: Researcher himself taught both experimental and control group. He taught them for the same duration of time and same unit which controls certain extraneous variables such as teacher's behavior, teacher's qualification and other activities.

Equivalence of Experimental and Control Group: Both the schools were conducted from the same resource centre and students of both schools were come from same level of society/culture. Also experimental and control group were equated with respect to the school grading. Researcher also visited the resource person of the resource centre and analysed the final exam result 2075B.S. of the both schools and it was found both could be taken as equivalent groups. By using pre-test scores, researcher found same result. Also, he calculated t-test to check the homogeneity of the variances of both groups and found that there was no significance difference between variances. And by using t-test for correlated samples and found that there is no difference between two means of two groups. By these conditions, researcher found two groups equivalent. Finally, by tossing a coin, researcher selected one group as experimental and other group as control group.

Teaching Methods: Researcher used same teaching methods for both groups. He used algebraic tile only for experimental group but not for control group.

Subject Matter: Same content was taught to both the experimental and control group from the same curriculum, same textbook prescribed by GON.

Length of the Experiment: Researcher devoted equal time duration to teach both experimental and control group. He taught 20 days duration in both groups by using two different techniques i.e. with using different algebraic tile for experimental group and without using algebraic tile in control group.

Students: Both schools were situated near to each other and lie on same resource centre. Both schools are similar in case of socio - economic status. There were eighteen student and fifteen students on Bagh Bhairab Boarding H.S. School and Kirti Secondary Boarding School. Kirtipur Kathmandu respectively. Fifteen students were selected for each school for experiment.

Dependent Variable: Students' Achievement

All the independent variables like teachers quality, student - teacher relation in teaching, teacher's behavior, qualification of teacher effects on the achievement of students; achievement of students is dependent variable in this study.

Tools of the study: The instrument of this study was achievement test, class observation, which is given below:

Achievement Test: An achievement test paper was the main instrument for data collection for the study. Some questions were developed by researcher himself, some questions were taken from teacher's guide and specification grid of grade VIII which were published from CDC, Sanothimi Bhaktapur, pilot study was adopted to establish the validity and reliability of the test item. For the pilot study thirty four items were kept. Among them twenty six were objective type and eight items were subjective type questions. After analysis of the pilot study, twenty five items were accepted and nine items were rejected.

Achievement Test Paper – I: An achievement test paper - I contained twenty-five items. Among them twenty were objective item and five were subjective items. All the questions were selected from the unit algebraic expression of grade – VIII from curriculum of lower secondary level. Twenty questions for one mark and five questions for four marks. Achievement test paper for pre-test was described in Appendix (see Appendix - A).

Achievement Test Paper – II: The achievement test paper – II was used for both the experimental and control group. This paper consists of only twenty-five items, twenty were of one mark, and five were of four marks. Length of the post-test was equal as the pre-test. The test was administrated on the experimental and control group at the final stage of the experiment. Achievement test paper for post-test was described in Appendix (see Appendix - B).

Observation Note: An observation note was prepared regarding classroom participation of the students, and students motivation towards manipulative teaching learning activities. Self-control of students while teaching using manipulative materials, perseverance (how students behave and feel while using manipulative materials in teaching algebra) and teacher's response towards manipulative materials were used. Based on these mention tools qualitative data have been collected and analysed.

Pre experiment stages

In this stage, at first the researcher developed achievement test paper for pre-test, which was reformed by pilot test than standardized by the subject expert and subject teacher. In addition, algebraic tile were collected. Teaching episodes were prepared.

Experimental stage

In this stage two separate groups were taught by different techniques i.e experimental group was taught by using manipulative materials and all the possible extractions variables are controlled for the effectiveness this strategy, where control group was taught by using conventional problem solving strategy. The researcher was taught both group for twenty days.

Post experimental Stages

It is the last stage of experiment in which two separate groups which had been taught by two different strategies during experimental stage are evaluated by taking their post –test and comparing mean value of each group obtained from pre-test and post test.as we found that the mean score of experimental group is better than control group due to the effectiveness of manipulative materials. To know the accurate validity of our experiment t-test was taken by using appropriate.

Estimation of Validity and Reliability of the Test

The school's subject teacher established the content validity of the test. To establish the reliability of the test, pilot study was administrated to 15 students of grade - VIII of Mangal Secondary School, Kirtipur, Kathmandu. Before administering the test paper, the researcher gave instructions about how to answer the given questions. Mean time was devoted two minutes per mark. The test consisted 34 items, 26 were objective and 8 were subjective. To finalize the suitable questions of the test, the researcher used achievement score to carry out the item analysis (See Appendix - C). For item analysis, 27% of upper and 27% of lower sources were identified.

Item Analysis of the Test

For the item analysis of the test paper, the researcher made thirty - four items in which twenty six were objective and eight were subjective type questions. To

analyze these items researcher selected 27% upper level scores' students and 27% lower level scores' students. Out of 34 questions, each correct response was denoted by '1' and incorrect response was denoted by '0'.

The difficulty level and discriminating index of one and four marks questions were separated by step wise with one mark and the average difficulty - level and discriminate index was calculated Ja.Ba.Ra. (2058, B.S.) Writes: the items having (30 - 70%) and discriminate index above 0.20 were accepted. So the item numbers 4,6,11,13 17,19 of one marks, item numbers 27, 29 and 31 were rejected after pilot study and item no. 12 was modified. The pre-test contained only twenty items of one mark, and five items of four marks.

Threats to Validity of the Study

Validity are classified into two categories internal and external validity. Internal validity is most concerned with strength and control of research design and its ability to determine causal relationship between dependent and independent variables (Campbell and Stanley, 2012). In this study the researcher control the different factors that affect the treatment of experimental and control group. Researcher controlled those students whose parental education and financial status are very high and also controlled those students who took tuition class regularly.

Similarly, external validity consists of a determination whether the result of the experiment and generalized to an entire population from which the sample was drawn in the study. Threats to external validity can create significant result during the experiment. In this study researcher brought those school which has almost same socio-economic status. On the case of teacher qualification, researcher himself had taught the both school. In the case of socio-economic status all students were likely from farmer and poor financial background. Textbook may be the intervening variable

for the student achievement but the researcher use the same book and same content for both groups. So, it did not impact the achievement. Hence, the researcher keeps all these variable as silent except using manipulative materials.

Data Collection Procedure

The researcher has granted permission from the school and subject teachers to conduct experiment. After getting permission from head teacher the researcher taught the students of grade VIII on both experimental and control group with using manipulative material after a week researcher take a pre-test on both group. Then the researcher take 20 class for experimental group with using manipulative materials (algebraic tile) and control group without using manipulative material and the researcher take post- test after completion of experimental classes and the mean marks of both group are compared by using t-test. For qualitative information the research would developed the semi structured interview guideline related to the manipulative teaching material to the students.

Data Analysis Procedure

Before analysing the data, it is necessary for organization of data and so that data has been organized by using computer. And verbal data had been converted into suitable numerical form. The collected data were analysed by using different statistical techniques, which were mean and SD. The T-test at 0.05 levels significances or the SPSS 21.0 statistical package was used to compare the mathematics achievement of students taught by using manipulative material and without using manipulative materials.

For qualitative, collected information from the observation and interview such as students motivation and the students participation in class room activities were analysed in a descriptive way.

Chapter-IV

ANALYSIS AND INTERPRETATION OF DATA

The most important part of the study is to analyze the collected data. The data collected in the form of large amount of information are to be reduced into simplified form. The present study entitled "The effect of manipulative materials in teaching mathematics at grade VIII" is an experimental study involving pre-test, post-test, equivalent groups design.

This chapter deals with the analysis and interpretation of data obtained from the achievement test of the sample students. The objectives of this study were to compare the achievement of mathematics of grade VIII student taught by using manipulative materials and without using manipulative materials, and to explore the feelings of students and their activities in the class while taught by using manipulative material teaching mathematics at grade VIII. These data were analyzed by using two tailed t-test for difference between two means. The data scores on achievement test were analyzed by using quantitative technique. For qualitative part, the researcher described the noted information from the basis of student participation, interaction, performance, regularity and interest on subject matter and also students learning difficulty and learning process was analyzed by using qualitative method.

Comparison of Mean Achievement Scores of Experimental and Control Groups

The research was experimental in nature. The achievement test was the basic tool for data collection to achieve the result for the objectives. Fifteen students from each school were selected. Research was intended to explore the effectiveness of the algebraic manipulative materials in teaching mathematics. In this study, obtained data were analyzed and interpreted under the following headings:

Analysis of Pre-Test Result

An individual Score of students from both of the experimental and control groups have been given in Appendix-D together with the statistical calculation of mean and standard deviation. The pre-test analysis for the comparison of the mean achievement scores of pre-test has been summarized in table-2.

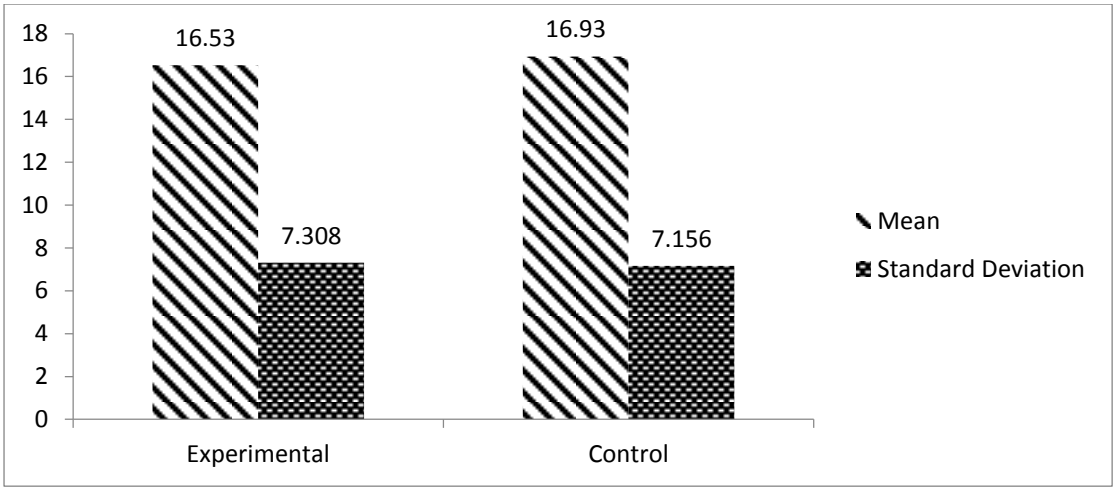
Table 2. ***Comparison of Experimental and Control Groups on Pre-test Score***

Group	Mean	S.D	t- value
Control (N=15)	16.93	7.156	-0.151
Experimental (N=15)	16.53	7.308	

The above table indicates that both mean and standard deviations are different. The scores of Mean, and standard deviation of the experimental group in pre-test are respectively found to be 16.53, and 7.308 whereas control group are 16.93 and 7.156. The difference in the mean achievement between experimental group and control group was found to be 0.4 so which is not significantly difference. The difference in standard deviation between experimental group and control group was found to be 0.152 so SD of experimental group is greater than the SD of control group. The Mean achievement scores of both groups were compared statistically using two tailed t-test at 0.05 level of significance. The table shows that the calculated value of t-test was 0.151 which is less than the tabulated value 1.96 at 0.05 level of significance with degree of freedom so the result of the t-test support the null hypothesis and there is no significance difference between mean achievement scores of experimental and control groups on pre-test scores.

Figure No. 1

Comparative Bar Graph Showing Achievement of Experimental and Control Group in Pre-test in Mathematics



The figure 1 shows that the mean score and standard deviation obtained from both experimental and control group in pre-test. The diagram indicates that there is no significance difference between mean score and standard deviation obtained from achievement scores in mathematics of both groups.

Analysis of Post-test Result

The post-test was administered to both experimental and control groups after the treatment was given. The post-test scores of students of experimental and control group had been presented in Appendix -E. The calculation of mean, standard deviation and variance had also been to calculate t-value as mentioned in Appendix G.

The summary of the t-test analysis for the comparison of mean scored of experimental and control groups have been given in table 3.

Table 3. ***Comparison of Experimental and Control Groups on Post-Test Scores***

Group	Mean	S.D	t- value
Control (N=15)	21.93	8.713	3.372
Experimental (N=15)	31.33	6.377	

The above table indicates that both mean and standard deviation are different. The mean scores of experimental group was found to be 31.33 and the mean scores of control group was 21.3 and standard deviation are 6.377 and 8.713 respectively. The difference in the mean achievement between experimental group and control group is found to be 10.03. The above table shows that the calculated value of t-test was 3.372 which is greater than the tabulated value 1.96 at 0.05 level of significance. So the result of the t-test does not support the null hypothesis that there is no significance difference between mean achievement scores of experimental and control groups on post-test scores. Thus, results of his study succinctly demonstrate that the use of manipulative material has positive impact on student's achievement in the mathematics.

Figure No. 2

Comparative Bar Diagram Showing Achievement of Experimental and Control Group on Post-test in Mathematics

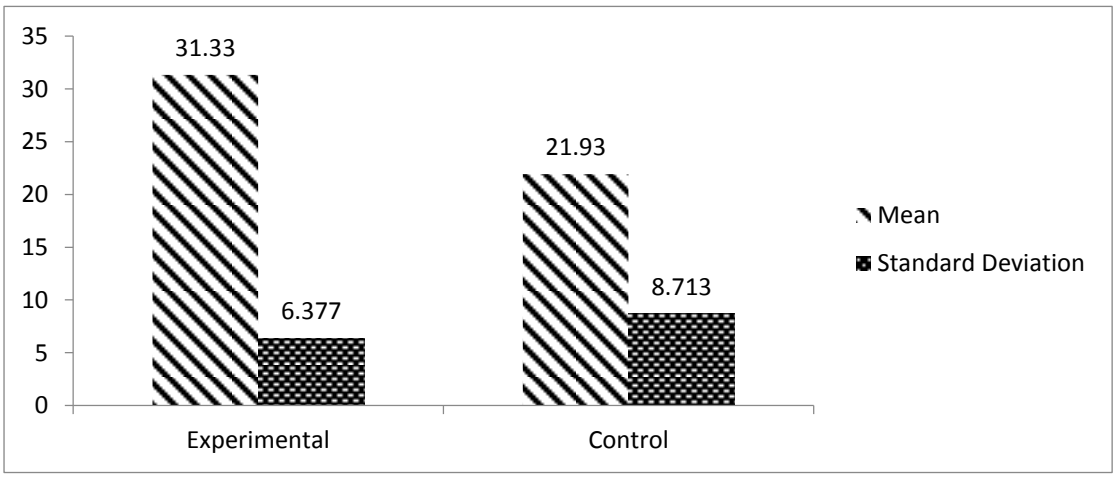


Figure 2 shows that the mean score and standard deviation obtained by the students of experimental and control group. In the post-test, the mean score of experimental group is 31.33 and control group is 21.93 Therefore, the mean score of experimental group is greater than the control group and the standard deviation of

experimental group is less than the control group. This result indicates that the experimental group has better result than the control group. Hence the achievement of the students taught by using manipulative materials is better than the achievement of the students taught without using manipulative materials.

Qualitative Analysis

Qualitative analysis is made on the basis of observation reports made by the researcher. On the basis of class room instruction the researcher observe the students activities noted daily. Informal algebra and visualization were vital aspects of algebraic program for class VIII. Algebra provided the opportunities for divergent thinking and creative problem while developing student logical thinking abilities. Students experience from algebra tiles help them learning vocabulary, properties of algebraic laws. Algebraic tiles help them and challenged to find alternative solutions. It also helps them to communicate their thinking in algebra. On the other hand, teaching algebra in control groups without using manipulative material was less interesting and motivating to clarify algebraic concept. It was also difficult to activate students as well as to create interest in the problem.

The researcher collected qualitative data as well as fulfil the objectives intended. It is believed that statistical tools in research work cannot support to obtain pinions, beliefs and feelings of respondents. In this research the researcher used interview as the tool to understand student's perception on using problem based learning strategy in terms of classroom participation of students and, Students motivation.

Classroom participation of students

Classroom participation of student is an essential act of building gradual confidence and efficiency on students. It encourage them to solve the mathematical

problem on their own through participation. So the researcher aim to explore where students are motivated to participate in the classroom actively while they are taught by using manipulative materials and without using manipulative materials. The researcher had conducted a semi structured interview with three student to explore whether they are motivated to participate in classroom activities by using manipulative material or not. This was mentioned below.

Researcher: Do you engage yourself to solve mathematical problem? Why?

Student 'A': *Yes, I engaged because it is interesting.*

Student ' B': *Yes it is easier way to solve mathematical problem.*

Student ' C': *sure, it is interesting so now a days I engaged to solve mathematical problem*

Most of the students viewed that they take part in the classroom activities while manipulative materials is used in teaching mathematics because it is interesting, sequential and interactive.

Researcher: Do you do your homework regularly?

Student 'A': *Yes make mathematics problem very easier than usual.*

Student 'B': *Sure, it make my study more entertainment.*

Student' C': *Of course, it helps to mathematical problem by stepwise process.*

From the above discussion it can be concluded that manipulative materials motivate students take part in the classroom discussion as it helps to discover alternative solution and it focus on participatory approach.

Researcher: Does manipulative materials in teaching motivates you to present mathematical solution in classroom? How?

Student 'A': *Sure it promotes to explore solution on my own way.*

Student 'B': *Yes I feel I am also one of the confident member having equal status in the groups.*

Student 'C': *Of course, it focus on classroom participation.*

So it can be concluded that students motivated to present in the classroom using manipulative materials in teaching algebra. It grows autonomous learners and builds up confident in them. On the other hand, it is promotes the participation, participant get immediate feedback which helps them to receive whether rewards and necessary correction.

Student's Motivation

Motivation is a potential to direct behavior that is built into the system that controls emotion. This potential may be manifested in cognition or behavior. Motivation is considered as a potential to direct ordering to the definition. To major students motivation the modified motivation scale used by Luc G. Pelletir Michelle Fortier, Robert J. Vallerand, Nathalie M Briere, Kim M. Tuson and Marc R.Blais (1995).In this research researcher selected 3 students so as to response regarding 3 items. The researcher conducted a semi structured interview with three students to explore whether they are motivated by using manipulative material in teaching algebra or not, which are given below.

Researcher: Do you think taught by using manipulative material helps to achieve good marks? How?

Student 'A': *Yes, it is stepwise technique to solve mathematical problem.*

Student 'B': *Yes, it is practical.*

Student 'C': *Sure, because it is student oriented class.*

From the above response, we can concluded that manipulative material in teaching algebra helps student to achieve good marks as it is practical, stepwise and interesting way to attempt algebraic problem.

Researcher: Did you find any changes in you while solving mathematical problems after using manipulative material in class.?

Student 'A': *Sure, I love mathematics class regularly.*

Student 'B'*: Of course, I solve mathematical problem regularly****.***

Student 'C': *Obviously, I fell as I can support my friend as well to solve mathematical problem.*

From above mention responses, can be concluded that students found many changes in them after using manipulative materials in teaching algebra. They took class regularly, did homework daily and felt more confidence in solving mathematical problem.

Researcher: Does manipulative material attracts your attention to solve mathematical problem?

Student 'A': *Obviously, it is practical in most mathematical problem.*

Student 'B': *Sure, it is not boring****.***

Student 'C': *Yes I feel that I am also one of the confident member having equal*.

Most of the respondents said that they play attention in the classroom while taught by using manipulative materials is used. Because it is practical, applicable in multiple areas and it is entertaining.

During experimental period researcher also found that every students of experimental group were curious and interested to learn algebra seriously and all the students were silent in the whole class period. Similarly, researcher had found that teaching was not effective on control group because students were not interested in

learning at the same way as usual. Hence, the researcher found that there was significance differences and effectiveness of manipulative materials in teaching algebra.

Chapter-V

SUMMARY, FINDINGS, CONCLUSION AND RECOMMENDATIONS

This chapter synthesizes the analysis of data gathered from primary and secondary sources as findings of the study and draws the conclusion of the study. And finally, the implication of the research and recommendation for future areas of research are presented.

Summary and Findings

The pre-test study intended to answer the question whether the performance of the students of secondary level taught by using manipulative material affect the mathematics achievement as compared to the performance of them taught by conventional problem solving strategy. For the data collection of the study, the researcher developed and tested the reliability of achievement test paper (pilot-test) and validity of the tools was ensured by expert judgment and secondary school mathematics curriculum. The test was consisted of objective multiple choice type items and subjective long answer type of question on the area of algebraic expression, from grade VIII.

A pre-test, post-test and non-equivalent control groups design was adopted for the purpose of this study. Students of grade-VIII in Bagh Bhairab Boarding High School and Kirti Secondary Boarding School were chosen for sampling purpose. Both groups were established on the basis of the pre-test results. Both experimental and control groups were taught by the researcher himself on the same selected units. The instruction period was 20 days only for experimental group. A post-test was administered to both groups providing necessary instruction for usual period on the same units. Along with other statistical measures; t-test was applied in order to ascertain the difference between two groups. The obtained data were analyzed and

interpreted statistically by using SPSS 21.0 and then the results were interpreted. Thus the following were the main findings of the study:

- T-test was used to compare mean scores of experimental groups and control groups on pre-test. The results of the test indicate that there was no significant difference between the groups at 0.05 level of significance.
- Using two-tailed test on post-test at 0.05 level of significance, it was found that the null hypothesis was not accepted. It indicates that the difference in mean achievement score in experimental and control groups was found significant.
- The achievement of grade VIII students who were taught mathematics using manipulative materials (Algebraic tile) achieve better score than the students who were taught without using material.
- The mean achievement scores of student taught with using manipulative is higher than mean achievement score of the student taught without using manipulative materials on post-test.
- The students of experimental group were found to be more motivated, curious and highly interested in teaching learning activities than that of control group.
- The classroom environment was friendly; student were engaged to learning among the experimental group as compared with the students of control group.

Conclusion

From the findings of the study, it could be concluded that students taught using manipulative materials performed significantly better compared to the control group. Research shows that using manipulative material in conjunction with other methods can deepen students' understanding of abstract concepts. Appropriate use of manipulative should be one component of a comprehensive mathematics instruction. Students perform better in Mathematics provided they are allowed to interact or participate effectively in the teaching learning process through the use of algebraic tiles. It was concluded that mathematics achievement of basic level significantly depends on the use of manipulative material. This shows that the students who were taught by using material are more active, regular participating in all activities of class room than the students who were taught without of manipulative material. So the algebraic tiles help the student to understand problems of algebra. Thus, use of manipulative material was effective in the mathematics at grade VIII. The usage of manipulative material has an added advantage on the mathematics achievement of the grade VIII students.

Recommendations for the better learning

On the basis of findings the study some measures have been recommended for the improvement of the teaching situation at grade 8 are given below:

- This study recommends that since student taught mathematics using manipulative material perform better than those who are taught mathematics using abstract mathematics symbols only the, children should be taught by use of algebraic tiles for the better performance in mathematics.

- Concrete materials, algebra tile manipulative be used as much as possible to introduce students to the concept of algebra.
- The math teacher should try to use available materials in teaching mathematics.
- The mathematics teachers should be encouraged to use different manipulative materials.

Suggestions for the Further Study

"Manipulative material must be used at the right time and in the right way, if they are to be effective" The materials must be selected with the mathematical purpose in mind. Based on findings and the scope of this study, suggestions for further studies to be carried out in the following areas:

- A research of the study should be carried out within the basic level context in other cities to determine the impact of using manipulative materials to teach mathematics when compared with only abstract mathematics symbols in order to improve achievement in mathematics in basic level pupils.
- A research study to be carried out in a different geographical region to determine the impact of using manipulative materials to teach mathematics when compared with only abstract mathematics symbols in order to improve achievement in mathematics in basic level student.
- A research study to be carried out to determine the impact of mathematics performance when taught using both manipulative materials and mathematical symbols to teach mathematics in basic level student.
- A research study to be carried out to further determine the impact of place value blocks on the achievement in mathematics basic operations.

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APPENDICES

Appendix A

Achievement test (for Pre - Test)

Student name: Class: 8

School name: Roll no:

Time: 1 hr. FM: 40

Sub: Mathematics PM: 10

Objectives Questions

1. What is the degree of $5x^2 - 7x - 2x + 3$?

a. 3 b. 2 c. 1 d. 0

2. If x=4, what is the value of $5x^2 + 6x – 3$?

a. 101 b. 205 c. 110 d. 200

3. $(a + b)^2$ is equal to?

a. $a^2 + 2ab + b^2$ b. $a^2 - 2ab + b^2$ c. $b^2 - 2ab - a^2$ d. $a^2 + 2ab - b^2$

4. What is the multiplication of $(x - 2)(x + 2)$?

a. $x^2 - 4$ b. $x^2 + 4$ c. $x^2 - 4x + 4$ d. $x^2 + 4x + 4$

5 What is the value of.$6x^2 - 12x \div 3x$?

a. $2x + 4$ b. $2x + 5$ c. $2x - 4$ d. $2x - 1$

6. What is the value of $a^2 x a^3$?

a. a^4 b. a^4 c. a^7 d. a^5

7. What is HCF of 36, and 42?

a. 5 b. 6 c. 7 d. 4

8. What is the factor of $5x + 10$?

a. $5(x + 2)$ b. $8(x + 5)$ c. $x(3x + 5)$ d. $x(2x - 5)$.

9 Expand form of $a^2 - b^2$ is?

a. (a - b) (a - b) b. (a + b) (a - b) c. (a + b) (b - a) d.(a + b) (a + b)

10. Expand form of $(a - b)^3$ is ?

a. $a^3 + a^2b + ab^2 + b^3$

b. $(a - b)^3 + 3ab$

c. $a^3 - 3a^2b + 3ab^2 - b^3$

d. $a^3 + 3ab + 3ab^2 + b^2$

11. Which formula do you use to factorize given algebraic expression:

$x^6 - 8$

a. $(a^2 - b^2)$ b. $(a^3 - b^3)$ c. $(a - b)^2$ d. $(a - b)^3$

12. What is the value of $(x + 2)^2$?

a. $x^2 + 2x + 4$ b. $x^2 + 4x + 4$ c. $x^2 + x + 2$ d. $x^2 + 2x + 2$

13. What is the volume of cube when a side is a unit?

a. a b. a^2 c. a^3 d. a^4

14. What is the volume of cube when a side is 3cm?

a. $9cm^3$ b. $3cm^3$ c. $27cm^3$ d. $18cm^3$

15. The degree of given expression is: $3x^4y^2 - x^2y^2 + xy$?

a. 2 b. 4 c. 6 c. 8

16. What is the HCF of $(a + b)^2$ and $(a^2 - b^2)$?

a. a + b b. a - b c. $(a + b)^2$ d. $a^2 - b^2$

17. Which are the correct factor of the expression, x^2+5x+6

a. (x+2) (x+3) b. (x+2) (x-3) c. (x+1) (x+4) d. (x+1) (x-4)

18. Find the value of $(a - b)^2$?

a. $a^2 + 2ab + b$ b. $a^2 - 2ab + b^2$ c. $a^2 + 2ab - b^2$ d. $b^2 - 2ab - a^2$

19. Which formula is correct to find the area of rectangle?

a. $l + b$ b. $l \times b$ c. $2(l + b)$ d. l^2

20. Find the value of $(2p - q)^2$?

a. $4p^2 – 4pq + q$ b. $2q^2 – 2pq + q^2$ c. $2q^2 + 2pq - q^2$ d. $2p^2 – pq - q^2$

Long Question

21. Show by using figure $a^2 - b^2 = (a + b)(a - b)$

22. Multiply, $(ab + ab^2)(2a^2 - 4ab + 2b^2)$

23. Show by using figure $(a + b)^2 = a^2 + 2ab + b^2$

24. If $x - y = 2$ and $xy = 15$, find the value of : $x^3 - y^3$

25. If $a - \frac{1}{a} = 5$ then prove that $a^3 - \frac{1}{a^3} = 140$

Appendix-B

Achievement test (for post -test)

Student name: class: 8

School name: Roll no:

Time: 1 hr. FM: 40

Sub: Mathematics PM: 10

Objectives Questions

1. What is the expand form of $a^2 - b^2$?

   a. (a - b) (a - b) b. (a + b) (a – b)

   c. (a + b) (b - a) d. (a + b) (a + b)

2. What is the expand form of $(a - b)^3$?

   a. $a^3 + a^2b + ab^2 + b^3$

   b. $(a - b)^3 + 3ab$

   c. $a^3 - 3a^2b + 3ab^2 - b^2$

   d. $a^3 + 3a^3b + 3ab^2 + b^3$

3. Which formula do you use to factorize the expression $x^6 - 8$?

   a. $(a^2 - b^2)$ b. $(a^3 - b^3)$ c. $(a - b)^2$ d. $(a - b)^3$

4. What is the volume of cube when a side is a unit?

   a. a b. a^2 c. a^3 d. a^4

5. What is the degree of given expression $3x^4y^2 - x^2y^2 + xy$?

   a. 2 b. 4 c .6 d. 8

6. What is the HCF of $(a + b)^2$ and$(a^2 - b^2)$?

   a. (a + b) b. a - b c. $(a + b)^2$ d. $a^2 - b^2$

7. What is the HCF of $2x^2 - 6x$ and $x^2 - 3x$?

a. x - 3 b. $x^3 - 3$ c. $x^2 - 3x$ d. x + 3

8. What is the value of $(a - b)^2$?

a. $a^2 + 2ab + b^2$ b. $a^2 - 2ab + b^2$

c. $a^2 + 2ab - b^2$ d. $b^2 - 2ab + a^2$

9. What is the HCF of $(x+ y)^2$ and$(x^2 - y^2)$?

a. (x + y) b. (x – y) c. $(x + y)^2$ d.($x^2 - y^2$

10. What is the HCF of $4p^2 – 6p$ and $p^2 – 3p$?

a. (p – 3) b.($p^3 – 3$) c. p(p – 3) d. (p + 3)

11. Which formula do you use to factorize given algebraic expression:

$x^4 - 25$

a. $(a^2 - b^2)$ b. $(a^3 + b^3)$ c. $(a - b)^2$ d. $(a - b)^3$

12. What is the value of $(x + 2)^2$?

a. $x^2 + 2x + 4$ b. $x^2 + 4x + 4$ c. $x^2 + x + 2$ d. $x^2 + 2x + 2$

13. What is the volume of cube when a side is 10 unit?

a. 100 b. 10 c. 1000 d. 10000

14. What is the volume of cube when a side is 3cm?

a. $9cm^3$ b. $3cm^3$ c. $27cm^3$ d. $18cm^3$

15. The degree of given expression is: $9y^2 - y^2 + xy$?

a. 2 b. 4 c. 6 d. 8

16. What is the HCF of $(x + y)^3$ and $(x^2 - y^2)$?

a. x + y b. x - y c. $(y + x)^2$ d. $x^2 - y^2$

17. Which are the correct factor of the expression, x^2+5x+6

a. (x+2) (x+3) b. (x+2) (x-3) c. (x+1) (x+4) d. (x+1) (x-4)

18. Find the value of $(3p - 9)^2$?

a. $3p^2 + 6pq + q^2$ b. $9p^2 - 54p + 81$ c. $3p^2 + 2pq - q^2$ d. $9p^2 - 27pq - 81$

19. Which formula is correct to find the area of rectangle?

a. $l + b$ b. $l \times b$ c. $2(l + b)$ d. l^2

20. Find the value of $(2p - q)^2$?

a. $4p^2 - 4pq + q^2$ b. $2q^2 - 2pq + q^2$ c. $2q^2 + 2pq - q^2$ d. $2p^2 - pq - q^2$

Long Question

21. Show by using figure $a^2 - b^2 = (a + b)(a - b)$

22. Multiply, $(ab + ab^2)(2a^2 - 4ab + 2b^2)$

23. Show by using figure $(a + b)^2 = a^2 + 2ab + b^2$

24. If $x - y = 2$ and $xy = 15$, find the value of : $x^3 - y^3$

25. If $a - \frac{1}{a} = 5$ then prove that $a^3 - \frac{1}{a^3} = 140$

Appendix – C
Item analysis of the Test

Student / Item	Upper 27% student giving correct response							Lower 27% student giving correct response									Rem.
	1	2	3	4	5	6	Total	1	2	3	4	5	6	Total	P%	D	
1	1	1	1	0	0	1	4	1	0	0	0	0	0	1	42	0.50	
2	1	1	0	1	1	1	5	1	0	1	0	0	0	2	58	0.50	
3	1	0	0	1	1	1	4	0	1	0	1	0	0	2	50	0.33	
4	1	1	1	1	1	0	5	1	1	1	0	0	1	4	72	0.16	Rejected
5	0	1	1	1	1	0	4	1	0	0	0	0	0	1	2	0.50	
6	1	0	0	0	0	0	1	0	0	0	0	0	0	0	16	0.16	Rejected
7	1	1	1	1	0	1	5	0	1	0	0	0	0	1	50	0.66	
8	1	1	1	1	1	1	6	1	0	0	0	0	0	1	42	0.83	
9	1	0	0	1	1	1	4	0	0	0	0	1	0	1	42	0.50	
10	1	1	0	1	0	1	4	0	1	1	0	0	0	2	50	0.33	
11	0	0	0	1	0	0	1	0	0	0	1	0	0	1	16	0	Rejected
12	1	1	1	0	1	1	5	1	1	0	1	0	0	3	48	0.32	
13	1	0	0	0	0	0	1	1	0	0	0	0	0	1	16	0	Rejected
14	0	1	1	1	1	1	5	1	0	0	1	1	1	4	72	0.16	
15	1	1	0	1	1	0	4	0	0	1	1	0	0	2	50	0.33	
16	1	1	1	1	0	1	5	1	1	1	0	1	0	4	75	0.17	
17	0	1	0	0	0	0	1	0	0	0	0	1	0	1	16	0	Rejected
18	1	1	0	1	0	1	4	1	1	0	0	1	1	4	50	0.33	
19	1	1	1	1	1	1	6	0	0	0	1	1	0	2	16	0.16	Rejected
20	0	1	0	1	1	1	4	0	1	1	0	0	0	2	42	0.50	
21	1	1	1	1	1	0	5	1	0	1	0	0	0	2	82	0.17	
22	1	0	0	1	1	1	4	0	1	0	0	0	0	1	59	0.17	
23	1	1	0	0	1	1	4	1	0	0	1	1	0	3	50	0.33	
24	1	1	1	1	1	1	6	1	1	1	0	1	1	5	92	0.17	
25	1	0	1	1	1	0	4	0	1	0	0	1	1	3	59	0.17	
26	1	0	1	1	0	1	4	1	0	1	0	0	1	3	42	0.50	
27	1	1	1	1	0	1	5	1	0	0	0	0	1	2	58	0.50	
	1	0	1	1	0	0	3	0	1	0	0	0	0	1	33	0.33	
	1	1	1	0	0	0	3	1	0	0	0	0	1	2	42	0.17	
	0	1	0	0	0	0	1	0	1	0	0	0	0	1	17	0	
															30	0.08	Rejected
28	1	1	0	1	1	1	5	0	1	0	0	0	0	1	57	0.67	
	1	1	1	1	1	0	5	0	0	0	1	0	0	1	57	0.91	
	1	0	0	0	1	1	3	0	0	0	0	0	0	0	56	0.50	
	1	1	1	0	0	0	3	1	0	1	0	1	0	3	45	0.17	
															36	0.33	
29	1	1	0	1	0	0	3	0	1	0	0	0	0	1	50	0.67	
	1	1	1	1	1	0	5	0	0	0	1	0	0	1	50	0.67	
	1	0	0	1	1	1	4	0	0	0	0	0	0	0	25	0.50	
	1	1	0	0	0	0	2	0	0	0	0	0	0	0	17	0.33	
															36	0.54	Rejected
30	1	1	0	1	1	1	5	0	1	0	0	0	0	1	50	0.67	
	1	1	1	1	1	0	5	1	0	0	1	0	0	2	50	0.67	

	1	0	0	0	1	1	3	1	0	0	0	0	0	0	25	0.50	
	1	1	0	0	0	0	2	0	0	0	0	0	0	0	17	0.33	
															36	0.54	
31	1	1	0	1	1	1	5	0	1	0	0	0	0	1	59	0.19	
	1	1	1	1	1	0	5	0	0	0	1	0	0	1	78	0.17	
	1	0	0	0	1	1	3	1	0	0	0	0	0	1	16	0.00	
	1	1	0	0	0	0	2	0	0	0	0	0	0	0	17	0.16	
															16	0.16	Rejected
32	1	1	0	1	1	1	5	0	1	0	0	0	0	1	52	0.65	
	1	1	1	1	1	0	5	0	0	0	1	0	0	1	54	0.66	
	1	0	0	0	1	1	3	0	0	0	0	0	0	0	28	0.57	
	1	1	0	0	0	0	2	0	0	0	0	0	0	0	18	0.35	
															40	0.58	
33	1	1	1	1	1	1	6	1	0	0	0	0	1	2	64	0.63	
	0	0	1	1	1	1	4	1	0	0	0	0	0	1	46	0.59	
	0	1	0	1	0	1	3	0	0	0	0	0	0	0	28	0.56	
	0	0	0	0	1	1	2	0	0	0	0	0	0	0	29	0.31	
															50	0.33	
34	1	1	1	1	1	1	6	1	1	0	0	0	0	2	65	0.63	
	1	1	0	1	1	0	4	0	0	1	0	0	0	1	45	0.54	
	0	0	1	0	1	1	3	0	0	0	0	0	0	0	24	0.56	
	0	1	0	1	0	0	2	0	0	0	0	0	0	0	23	0.33	
															48	0.47	
Sum Odd	22	19	13	20	16	14		12	8	5	7	5	4				
Sum Even	25	22	15	18	19	20		13	12	6	6	5	5				
Sum Total	47	31	28	38	35	34		25	20	11	13	10	9				

Appendix –D

(Pre-test result of experimental and control group)

In descending order

S.N.	Experimental group	Control group
1	28	29
2	27	28
3	25	27
4	22	20
5	22	19
6	22	19
7	17	18
8	15	17
9	15	17
10	12	14
11	10	12
12	9	12
13	9	11
14	8	9
15	7	7
N=15	Mean = 16.53 Standard deviation – 7.308	Mean = 16.93 Standard deviation = 7.156

Appendix – E

(Post - test result of Experimental and control group)

In descending order

S.N.	Experimental group	Control group
1	40	35
2	40	33
3	38	30
4	35	30
5	35	27
6	34	25
7	34	25
8	33	24
9	30	23
10	30	18
11	29	17
12	28	15
13	24	9
14	20	7
15	20	6
N=15	Mean = 31.33 Standard deviation =6.377	Mean = 21.93 Standard deviation 8.713

Tiles Used in Teaching Algebra

Algebra tiles are manipulative materials. Algebra tiles are geometric model that explores algebraic concepts. Algebra tiles are used to solve the problems of addition, subtraction, algebraic expression and equation of mathematics many of the real tiles have a positive and negative tiles. It helps to understand the tiles have one positive and negative dimension. Algebra tiles are made of wood and other materials. The used tiles make the algebraic concept clear for the students. For example

Appendix - E_1

Model of Lesson Plan Based on Conventional Method

For Control Group

School: Date:

Subject: Mathematics Time: 45 Mines

Unit: Algebraic expression Class: 8

Topic: Squares of Polynomials

1. Specific objective

After the completion of this lesson the students will be able to:

a. Derive $(a + b)^2 = a^2 + 2ab + b^2$

b. Apply the formula to solve related problem.

1. Teaching Aids.

Daily used materials.

2. Teaching Learning Activities:

Reviewing the previous lesson, today's lesson follows the following activities:

Reviewing the previous lesson, the teacher will clarify the expansion of $(a + b)^2=a^2 + 2ab + b^2$, $(a - b)^2= a^2 - 2ab + b^2$ by using the different teaching methods: problem solving, discussion, demonstration respectively.

4. Evaluation:

a. What is the extension of $(a + b)^2$?

b. Simplify $(2x + 3)^2$ applying the formula, $(a + b)^2$.

5. Homework:

Do the followings

a. $(a + b)^2$ b. If $x + \frac{1}{x} = 3$ find the value of $x^2 + \frac{1}{x^2} = ?$

c. $(a^2b + b^2c)^2$ d. Simplify: $(2x + 5)^2 + (6x + 3)^2$

Appendix E_2

Lesson Based on the Used of Models (For Experiment Group)

Lesson Plan No. 1

School: Date:

Subject: Mathematics Time: 45 Mins

Unit: Algebraic expression Class: 8

Topic: Different of Two Squares

1. Specific objective:

After the completion of this lesson the students will be able to

a. Define $a^2 - b^2=(a + b)(a - b)$

b. Apply the formula to solve related problem.

2. Teaching materials:

Daily used materials and different models having area of a^2 & b^2.

3. Teaching learning activities:

During the class period the teacher will do the following activities.

a. To show the extensive form of $(a^2 - b^2)$ showing pieces of a^2 & b^2 the teacher will conduct the following activities using the different teaching methods: problem solving, discussion and demonstration respectively.

Activity No. 1

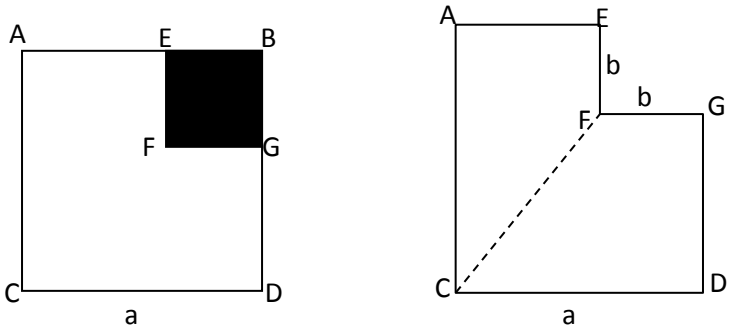


Fig. No. 1

Area of ABCD = a^2

Area of EFGB = b^2

Activity No. 2

Area of ADGE = (a + b) (a - b)

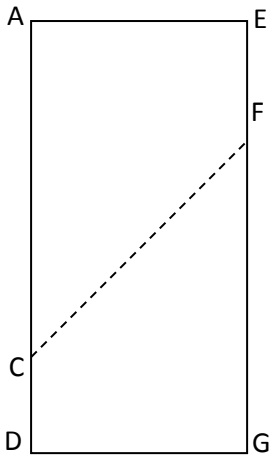


Fig. No. 2

4. Evaluation

a. What is the extension of $(a + b)^2$

b. Simplify: $(2x)^2 - 9$

5. Homework

Do the following

a) $a^2 - \frac{1}{a^2}$ b) $p^2 - 25q^2$ c. $25x^2 - (3x + 1)^2$

Lesson Plan No. 2

School: Date:

Subject: Mathematics Time: 45 Mins

Unit: Algebraic expression Class: 8

Topic: Different of Two Squares

1. Specific objective:

After the completion of this lesson the students will be able to

a. Show $a^2 - b^2 = (a + b)(a - b)$

b. Apply the formula to solve related problem.

2. Teaching materials:

Daily used materials and different models having area of $a^2 - b^2$ and ab.

3. Teaching learning Activities:

Reminding the previous lesson to the students, the teacher completes the new lesson conducting the following different activities:

a. to show the extensive form of $(a + b)^2$ showing the different pieces of wood having areas of a^2, b^2 and ab, the teacher will conduct the following activities using different teaching methods: Problem solving, discussion and demonstration respectively.

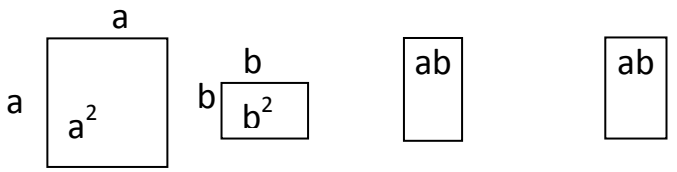


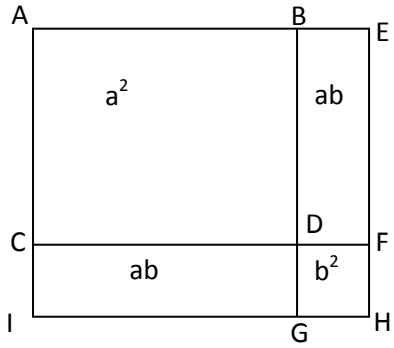
Fig.1

Fig.2

Fig.3

Fig.4

Area of figure no. 1,2,3,4 are a^2, b^2 ab, ab

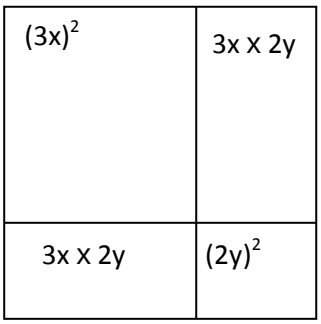


Area of AEHI = Ar. ABDC + Ar. CDGI + Ar. DGHF + AR. BDFE

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

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

b. To make clear the students, makes different models of other expression having $(a + b)^2$



In this figure $9x^2 + 6xy + 6xy + 4y^2$

$= 9x^2 + 12xy + 4y^2$

4. Evaluation:

a. What is the extension of $(a + b)^2$?

b. Simplify: $(2x + 3)^2$ applying the formula, $(a + b)^2$.

5. Homework:

Do the following

a. $(a + b)^2$ b. If $x + \frac{1}{x} = 3$ find the value of $x^2 - \frac{1}{x^2} = ?$

c. $(a^2b + b^2c)^2$ d. Simplify : $(2x + 5)^2 + (6x + 3)^2$

Lesson Plan No. 3

School: Date:

Subject: Mathematics Time: 45 Mins

Unit: Algebraic expression Class: 8

Topic: Different of Two Squares

1. Specific objective:

After the completion of this lesson the students will be able to

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

b. Apply the formula to solve related problem.

2. Teaching materials:

Daily used materials and different models having area of a^2, b^2 and ab.

3. Teaching learning activities:

Reminding the previous lesson to the students the teacher. Complete the new lesson conducting the following different activities.

a. To show the extensive from of $(a - b)^2$, showing the different pieces of wood having area a^2, b^2 and ab the teacher will conduct the following activities using different teaching methods: problem solving, discussion and demonstration respectively.

Activity No. 1

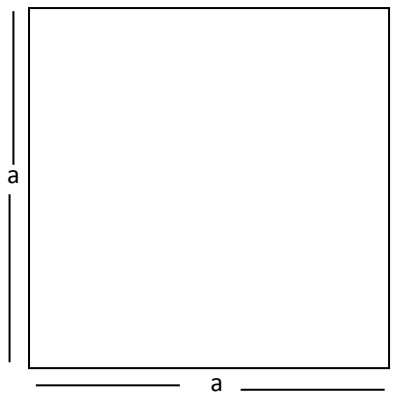


Figure No. 1

Activity No. 2

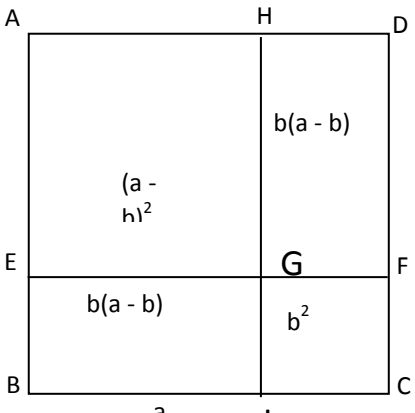


Figure No.2

Area of Figure no. 1 = a^2

Area of figure no. 2 ABCD = Area of (AEGH + GHDF + BEGI + GICF)

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

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

b. To make clear the students make different models of other expression having $(a - b)^2$.

4. Evaluation

a. What is the extension of $(a - b)^2$.

b. Simplify $(2y - 1)^2$ applying the formula $(a - b)^2$.

5. Homework:

a. Simplify: $(2a - 1)^2$

b. If $x - \frac{1}{x} = 3$, find $x^2 + \frac{1}{x^2} = ?$

c. Expand: $(a^2b - c^2c)^2$

d. Simplify: $(2x - 5)^2 + (6x - 3)^2$

Lesson Plan No. 4

School: Date:

Subject: Mathematics Time: 45 Mins

Unit: Algebraic expression Class: 8

Topic: Factorization of trinomials of the type $px^2 + qx + r$.

1. Specific objective

After the completion of this lesson the students will be able to:

a. Factorization of trinomials forms $px^2 + qx + r$

2. Teaching materials

Dairy used materials and different models having x^2, x and unit.

3. Teaching learning activities

During the class period the teacher will do the following activities.

a. To show the extensive form $px^2 + qx + r$, showing the different pieces of wood having area x^2, x and unit, the teacher will conduct the following activities using different teaching methods: Problem solving, discussion and demonstration respectively.

Ex: $x^2 + 5x + 6$

Activity No. 1

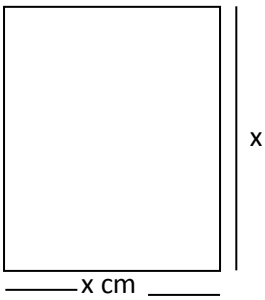


Figure No. 1

Figure No. 2

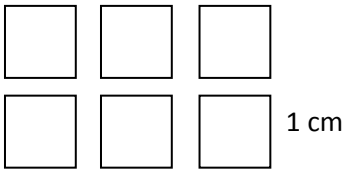


Figure No. 3

Here, Area of figure no. 1=x^2

Area of figure no. 2= x x 1=X

Area of figure no. 3= 1x1=1

In the above pieces of wood construct the rectangle.

Activity No. 2:

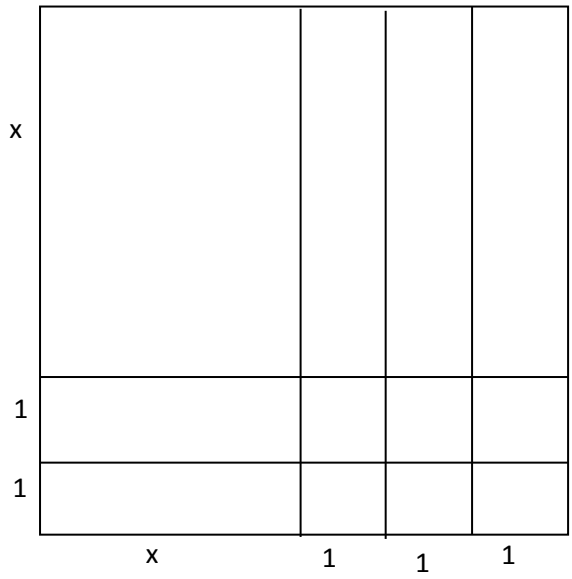


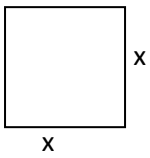
Figure No. 4

Are of above figure no. 4 = (x + 2) x (x + 3)

∴We conclude that $x^2 + 5x + 6 = (x + 2) x (x + 3)$

b. To make clear the students make different models of another factorization.

4. Evaluation:



What is the area of this figure?

Evaluation is embedded within the activities.

5. Homework:

Do the following:

a. $x^2 + 7x + 12$ b. $x^2 + 4x - 3$

c. $5p^2 + 18pq + 9q^2$ d. $4x^2 + 5x - 1$

Lesson Plan No. 5

School: Date:

Subject: Mathematics Time: 45 Mins

Unit: Algebraic expression Class: 8

Topic: Factorization of trinomials of the type $px^2 + qx + r$.

1. Specific objective

After the completion of this lesson the students will be able to:

a. Factorize of trinomial forms of $px^2 - qx - r$

2. Teaching materials:

Daily used materials and different models having x^2, - x, + x & unit.

3. Teaching learning activities:

During the class period the teacher will do the following activities.

a. To show the extensive form $px^2 - qx - r$, showing the different pieces of wood having area x^2, x, -x & unit the teacher will conduct the following activities using different teaching methods: questionnaire, discussion and demonstration respectively.

Ex: Factorized $x^2 - x - 6$

Activity No. 1

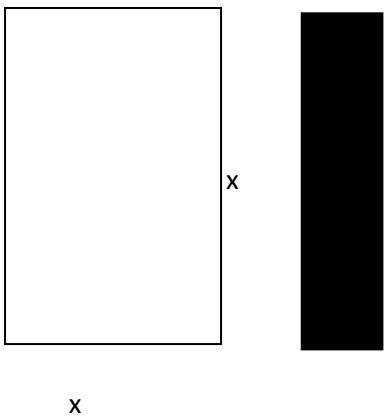


Figure No. 1

Figure No. 2

Figure No. 3

Area of figure no. 1 = x^2

Area of Figure no. 2 = - x

Area of figure no. 3 = - 1

Activity no. 2

An attempt was made to construct the rectangle using above pieces.

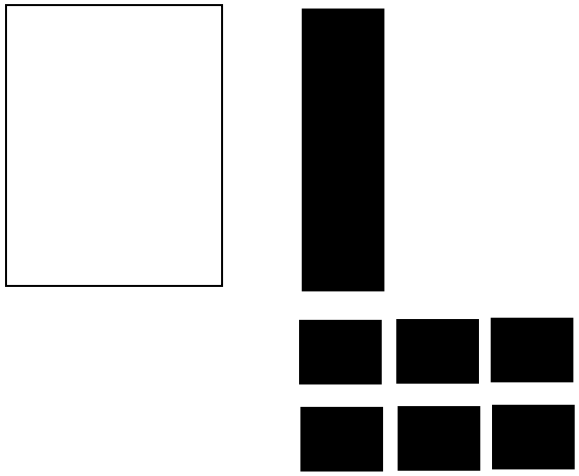


Figure No. 4

Activity no. 3

Here, above figure complete the rectangle add + 2x & - 2x

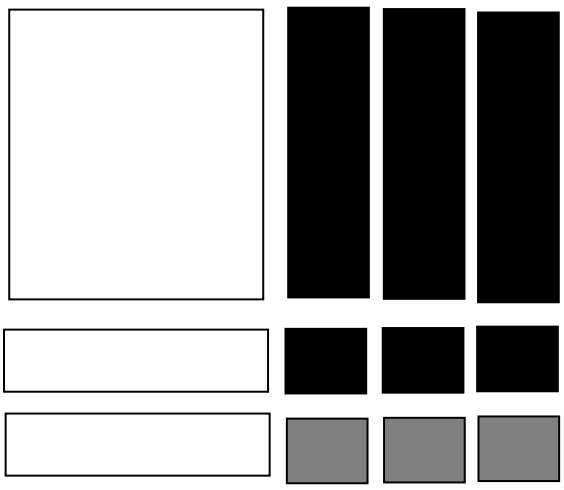


Figure No. 5

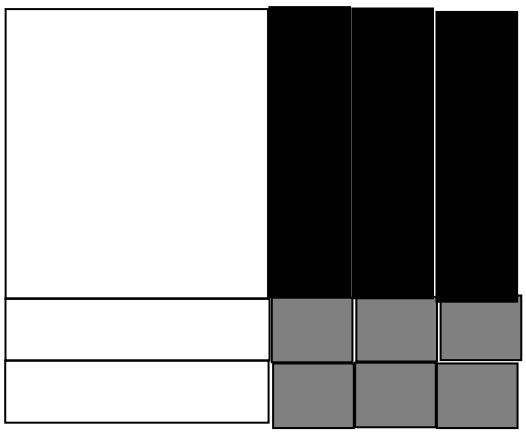


Figure No.6

Area of Figure No. 6 = (x + 2) (x - 3)

$\therefore x^2 - x - 6 = (x - 3)(x + 2)$

4. Evaluation:

Evaluation is embedded within the activities.

5. Homework:

Do the following:

a. $6x^2 - x - 15$ b. $8x^2 - 6x - 9$

c. $x^2 - x - 72$ d. $p^2 - 3p - 4$

Lesson Plan No. 6

School: Date:

Subject: Mathematics Time: 45 Mins

Unit: Algebraic expression Class: 8

Topic: Cube of Polynomials.

1. Specific objective

After the completion of this lesson the students will be able to:

a. Derive $(a + b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$

2. Teaching materials:

a. To show the extensive form of $(a + b)^3$, showing pieces of a^3, b^3, a^2b, ab^2 the teacher will conduct the following activities using the different teaching methods problem solving, discussion and demonstration respectively.

Activity No. 1:

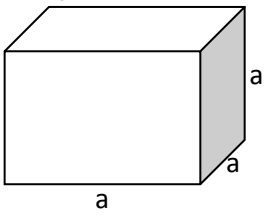


Figure No.1

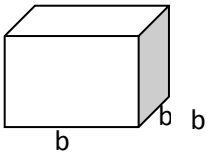


Figure No.2

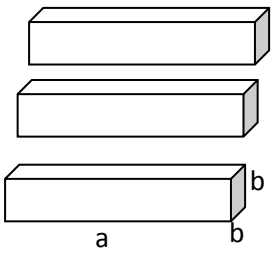


Figure No.3

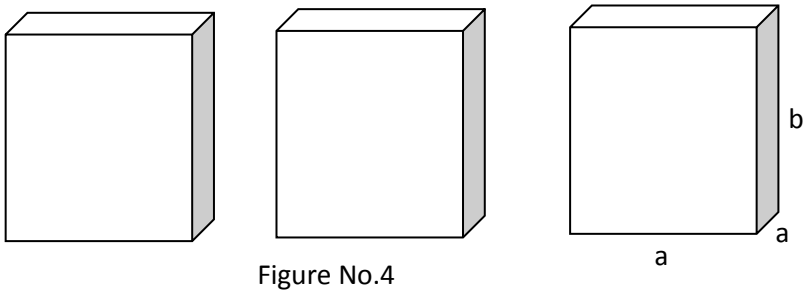


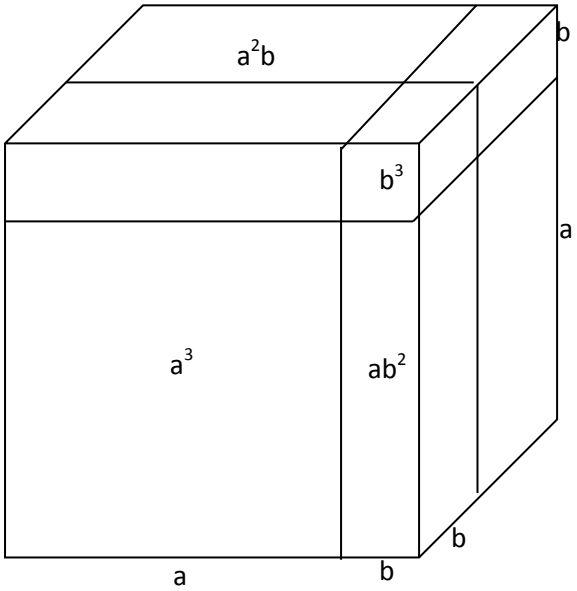
Figure No.4

Here, Volume of Figure no. 1 is a^3 Volume of figure no 2 is b^3

Volume of figure no. 3 is ab^2 Volume of figure no. 4 is a^2b

Activity No. 2

On the basis of above shown pieces of wood, to construct the cube.



We can demonstrate this result using a cube having the length of (a - b) units as in following

We can see using the actual physical model that

$(a + b)^3 = a^3 + a^2b + a^2b + a^2b + ab^2 + ab^2 + ab^2 + b^3$

$= a^3 + 3a^2b + 3ab^2 + b^3$

3. Evaluation

a. What is the expression of $(a + b)^3$

b. What is the volume of cube?

5. Homework

Do the following

a. $(2x + 3y)^3$

b. $(a^2 + b)^3$

c. $\left(3x + \frac{1}{3x}\right)^3$

d. $\left(\frac{2}{p} + p\right)^3$

Lesson Plan No. 7

School: Date:

Subject: Mathematics Time: 45 Mins

Unit: Algebraic expression Class: 8

Topic: Cube of Polynomials.

1. Specific objective

After the completion of this lesson the students will be able to:

a. Derive $(a - b)^3 = a^3 - 3a^2b + 3ab^2 - b^3$

2. Teaching materials:

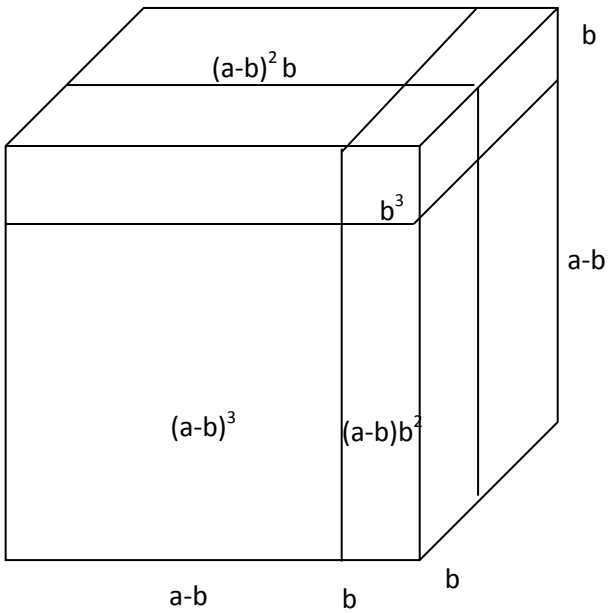
Daily used materials and different models having value of a^3, b^3, $(a - b)^3$.

$(a - b)b^2$ & $(a - b)^2 x b$

3. Teaching learning activities:

a. To show the extensive form of $(a - b)^3$. Showing pieces of a^3 the teacher conducts the following activities using the different teaching methods. Problem solving, discussion and demonstration respectively.

Activity No. 1:



Volume of this cube = a^3

Now from the solid a^3 let's take out in all sides: height, length and breath. It is shown in figure No. 2.

Activity No. 2

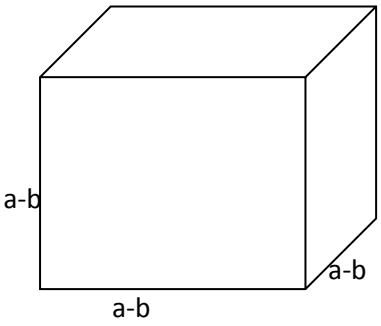


Figure No. 2

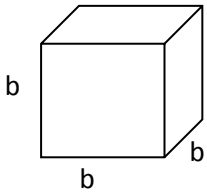


Figure No. 3

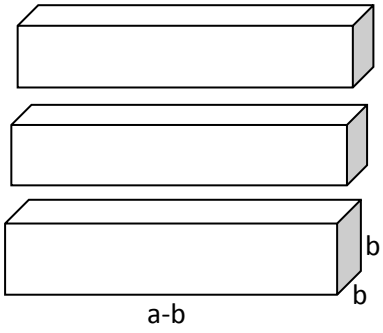


Figure No. 4

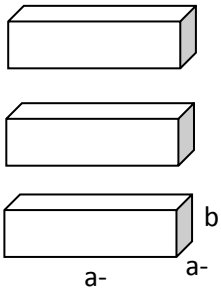


Figure No.5

Here, this cube is divided into eight pieces, whose volume are $(a + b)^3$, $3 \times b^2(a - b)$, $3 \times (a - b)^2$ & b^3

$\therefore a^3=(a - b)^3 + 3b^2(a - b) + 3b(a - b)^2 + b^3$

or,$a^3 = (a - b)^3 + 3a^2b - 3b^3 + 3a^2b - 6ab^2 + 3b^3 + b^3$.

or, $a^3 = (a - b)^3 + 3a^2b - 3ab^2 + b^3$

or, $a^3 - 3a^2b + 3ab^2 - b^2 = (a - b)^3$.

4. Evaluation

a. What is the extension of $(a - b)^3$.

b. Simplify: $(2y - 1)^3$.

5. Homework:

Do the following:

a) $(2x - 1)^3$ b) $\left(x-\frac{1}{x}\right)^3$ c. $(a^2b - c^2)^3$

Lesson Plan No. 8

School: Date:

Subject: Mathematics Time: 45 Mins

Unit: Algebraic expression Class: 8

Topic: Cube of Polynomials.

1. Specific objective

After the completion of this lesson the students will be able to:

a. Derive $a^3 + b^3 = (a + b)(a^2 - ab + b^2)$

2. Teaching materials:

Daily used materials and different models having volume of a^3, b^3, a^2b, ab^2.

3. Teaching learning activities:

During the class period the teacher will do the following activities.

a. To show the extensive form of $a^3 + b^3$, showing pieces of a^3, b^3, a^2b, ab^2, the teacher will conduct the following activities using the different teaching methods: problem solving, discussion and demonstration respectively.

Activity No. 1

Here, a^3, b^3 be two pieces of wood and make a cube in this figure.

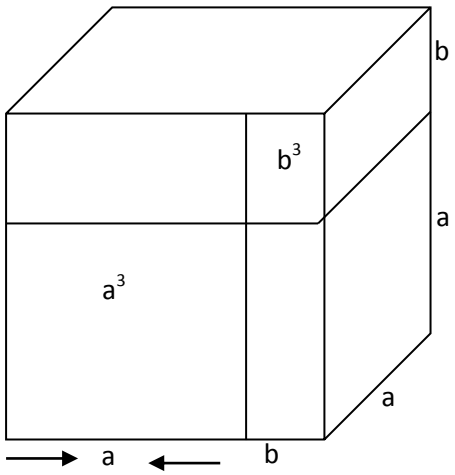


Figure No. 1

Activity No. 2

From above figure, there are eight pieces of cube.

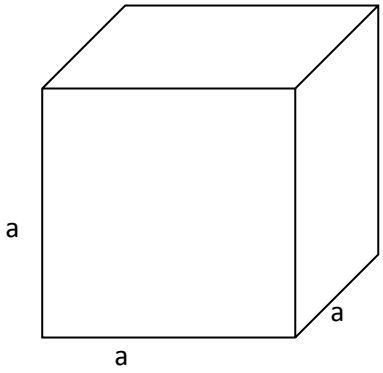


Figure No. 2

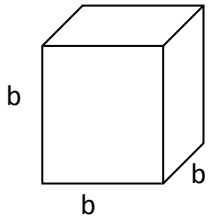


Figure No. 3

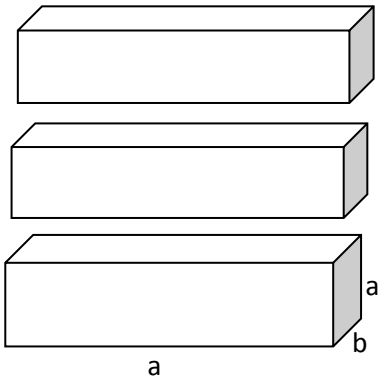


Figure No. 4

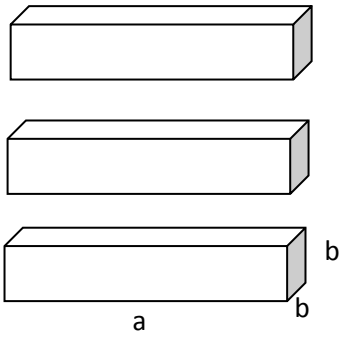


Figure No.5

Volume of Figure No. 1 = Volume of (Fig. No. 2 + Fig. No. 3 + Fig. No. 4 + Fig No. 5)

$$(a + b)^3 = a^3 + b^3 + 3a^2b + 3ab^2$$

$$\therefore (a + b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$$

$$(a + b)^3 = a^3 + 3ab(a + b) + b^3$$

$$(a + b)^3 - 3ab(a + b) = a^3 + b^3$$

$$a^3 + b^3 = (a + b)(a^2 - ab + b^2)$$

5. Evaluation:

What is the extension of $a^3 + b^3$=?

6. Homework

a. $x^3 + 27$ b. $a^3 + \frac{1}{a^3}$ c. $x^3 + (a + b)^3$ d. $8x^3 + 125$

Lesson Plan No. 9

School: Date:

Subject: Mathematics Time: 45 Mins

Unit: Algebraic expression Class: 8

Topic: Different two cube.

1. Specific objective

After the completion of this lesson the students will be able to:

a. Derive $a^3 - b^3 = (a - b)(a^2 + ab + b^2)$

2. Teaching materials:

Daily used materials and different models having volume of a^3, b^3, $a^2(a - b)$. $ab(a - b)$, $b^2(a - b)$.

3. Teaching learning activities:

During the class period the teacher will do the following activities.

a. To show the extensive from of $a^3 - b^3$ showing pieces of a^3, b^3, $a^2(a - b)$. $ab(a - b)$, $b^3(a - b)$, the teacher will conduct the following activities using the different teaching methods: problem solving , discussion and demonstration respectively.

Activity No. 1

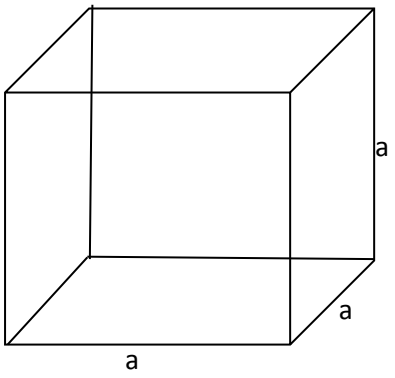


Figure No. 1

Volume of Solid (Figure NO. 1) = a^3

Activity No. 2

Now from the solid a^3, let's cut off b^3. It will be more convenient to take out b^3 from a^3.

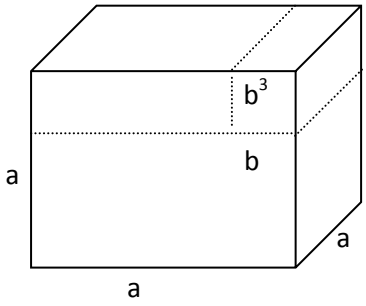


Figure No. 2

Now, we have to calculate the volume of this solid. We can split it into three different cubes.

Activity No. 3

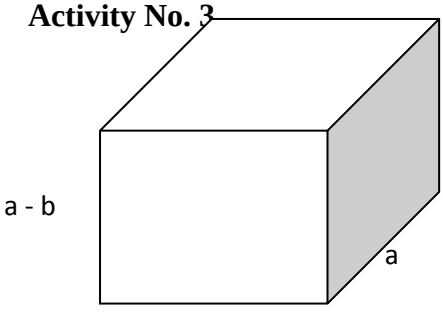


Figure No. 3

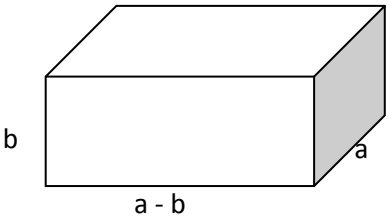


Figure No. 4

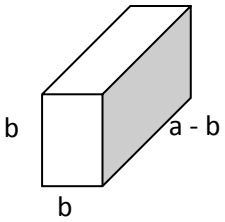


Figure No. 5

The total volume of Figure No 2 = Volume of (fig. No. 3 + fig. No. 4 + fig. 5)

$a^3 - b^3 = a^2(a - b) + ab(a - b) + b^2(a - b)$

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

4. Evaluation

Evaluation provided the activities.

5. Homework:

a. $(2x)^3 - \left(\frac{1}{4}\right)^3$ b. $a^3 - \left(\frac{1}{a^3}\right)$ c. $a^3 - 27$