EFFECT OF MANIPULATIVE MATERIALS ON TEACHING MATHEMATICS

A

THESIS

BY

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IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE

DEGREE OF MASTER IN MATHEMATICS EDUCAT ION

SUBMITTED

TO

DEPARTMENT OF MATHEMATICS EDUCATION

CENTRAL DEPARTMENT OF EDUCATION

UNIVERISYT CAMPUS

TRIBHUVAN UNIVERSITY

KIRTIPUR, KATHMANDU

2019

Letter of Certificate

This is certify that **Mr. Sanjay Kumar Yadav**, a student of academic year 2069/70 with Campus Roll Number 340, Thesis Number 1131, Exam Roll Number 280268 and T.U. Registration Number 9-3-28-66-2011 has completed this thesis for period prescribed by the rules and regulations of Tribhuvan University, Kirtipur, Kathmandu, Nepal. The thesis entitled "Effect of Manipulative Materials on 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's of Education.

…………………………….

(Assoc. Prof. Laxmi Nararayan Yadav)

Head

Letter of Approval

This thesis entited **Effect of Manipulative Materials on Teaching Mathematics** submitted by Mr. Sanjay Kumar Yadav in partial fulfillment of the requirements for the Master's Degree in Education has been approved.

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(Supervisor)	

Date:…………………………

Recommendation for Acceptance

This is to certify that Mr. Sanjay Kumar Yadav has completed his M.Ed. thesis entitled **Effect of Manipulative Materials on Teaching Mathematics** Under my supervision during the period prescribed the rules and regulations of Tribhuvan University, Kirtipur, Kathmandu, Nepal. I recommend and forward his thesis to the Department of Mathematics Education to organize final viva-voce.

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Date …………………..

Acknowledgements

Abstract

This study intended to determine **Effect of Manipulative Materials in Teaching Mathematics** at grade VI. It was pre-test, post-test, non-equivalent and experimental design .The researcher has choosed 15 students of grade VI. Shree Sundra Janta Secondary School Aurahi-5 as an experimental group and 15 students of Shree Lower Secondary Tenuwapatti Itatar -4 as a control group. The objective of this study was to find out the effect of the use of manipulative materials in teaching at class VI and to compare the achievement of the students that taught by using manipulative materials and the students that taught without using manipulative materials. This study was an experimental study conducted at grade VI in the two public lower secondary schools. Experimental and control groups of student were made homogeneous as nearly as possible in the basis of pre- test, scores, class size and keeping the number of student and Experimental and control groups were taught. The same topic, same teacher, same time/Duration and same economic status by using manipulative materials and conventional teaching approaches at experimental and at control groups respectively. The duration of the experimental and control groups have been 30 Days. After completing the experimental teaching, the standardized test was prepared by the researcher and administered in both the group of students. The achievement mean scores were calculated . The difference in mean achievement scores were tested using t-test for determine statistically difference between them. The t-test at the 0.05 level of significance showed that manipulative materials approaches of teaching was better than the conventional approach of teaching in mathematics. It was found that the mean score of the students of experimental group was greater than the mean score of the students of control group. statistically the difference between the mean scores was significant. Thus the researcher concluded that the use of manipulative materials was effective in teaching mathematics at lower secondary level.

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CHAPTER I

INTRODUCTION

Background of the Study

Mathematics is an important part of human civilization. It is essential for day to day life as well as for higher study in science and technology. It is essential for everyone, rich or poor, in every activity related to the mankind. The importance of mathematics has been realized and accepted since the beginning of school education in Nepal. Students apply mathematical concepts, skills and logical reasoning to solve different kinds of problems in mathematics. To make clear concepts of mathematical problems, the use of manipulative materials plays a major role. Students get the idea about it by touching ,looking and feeling it and can make a concrete model in their brain about the topic.

The word "manipulate" originates from the Old French word "manipüle", meaning "handle". In English it means "to move or control, to operate, to manage with one's hands". When the literature is reviewed for the definition of "manipulative" as a mathematical concept, several definitions which present the features of the Manipulatives are found. Manipulatives are concrete learning materials that allow students to comprehend abstract concepts through concretizing them (Boggan, Harper, & Whitmire, 2010).Thus help them to establish a relation between the manipulatives and abstract mathematical concepts by offering concrete experiences and eventually, provide long-term permanence of mathematical skills .

Manipulatives enable students to integrate their knowledge and associate them with their thoughts in order to understand mathematical concepts thoroughly (Boggan,

Harper, & Whitmire, 2010); They contribute to students' communication with their own mathematical thinking and to bringing their mathematical ideas to a higher cognitive level. They also evoke amusement in the teaching process by providing active participation of both students and teachers and in this way, lead to permanent learning through creating equality of opportunity among students.

The historical development of instructional materials in Nepal beings along with the establishment of the Nepal national educational planning commission (NNEPC) in 1954. Prior to this only few texts books and blackboards were used as the main instructional materials. Apart the establishment of "Janak shiksha samagri kendra" in 1962 A.D. , More stress was given for the construction, distribution and proper use of instructional materials throughout Nepal . In this context, Nepal education system plan (NESP. 1971AD) emphasized the instructional materials as, "To make modern, effective and scientific teaching, more instructional materials should be used either those materials prepared by JSSK or it will provide sample to other in preparation of such materials. (Regmi, 2006).

Except the elementary mathematical concepts, almost all part of mathematics I abstract and logical in nature. That was why instructional materials play enhancing role for effective mathematics teaching and there are quite essential for the concretization of abstract mathematics content. According to the nature and utility of instructional materials, they can be classified into the categorizes as literature, Audio-visual aids and manipulative materials. Among these materials, manipulative materials play vital role for improving teaching learning process.

Manipulative Materials

Educational materials that are designed to be touched as handle by students and which develop their muscles, perception skills; psychomotor skills, etc are called manipulative materials. Accounting to oxford dictionary, "manipulative materials are those materials which skillfully used by hands", manipulative materials are concept models that involve mathematics concepts, appending several sense, that can be touched and moved around by the students.

Manipulative materials come in a variety of forms and they are often defined as physical objects that are used as teaching tools to engage students in the hands-on learning of mathematics. Manipulative can be purchased at a store, brought from home, or teacher and student made. The manipulative can range from dried beans and bottle caps to unfix cubes and base-ten blocks. They are used to introduce, practiced, or remediate a math concept. A good manipulative bridges the gap between informal math and formal math. To accomplish this objective, the manipulative must fit the developmental level of the child. Kindergarten children should have individual counters, whereas older students could use colored wooden rods that represent different numbers. The manipulative must fit the mathematical ability of the child or it is useless.

Manipulative materials can be used in teaching a wide variety of topics is mathematics, including the objectives from the five NCTM standards: problem solving, communicating, reasoning, connections, and estimation. The materials should foster children's concepts of numbers and operations, patterns, geometry, measurement, data analysis, problem solving, reasoning, connections, and

representation .Teachers could use counters, place-value mats, base-ten blocks, and fraction strips while teaching from the numbers and operations standard.

Manipulative materials are useful for the counting with addressing / expressing be use, one-on-one correspondence, ordinal numbers, and basic addition and subtraction. The fraction strips could be used to add and subtract fractions or to show equivalent fractions. Pattern blocks, attribute blocks and scales could be used to assist students in the learning basic algebra. Student could use geo-board when trying to identify simple geometric shapes. They could also use geometric solid models when measuring cups to represent length or volume in measurement lessons. The students could also and probability, students could use panniers to find the area or perimeter of an object. When it comes to data analysis and probability, students could use spinners to find the probability of landing on a designated area. They could also use number cases or dice to find the probability of rolling a certain number or combination of numbers .

Mathematics specialist for grades Kindergarten through fourth grade at Pough keespsie Day School in New York, created 'math tubes' to mathematics interest for both kids and their parents. Each Friday several students are selected to receive a mathematics tubes, which are not due back until the next Wednesday. The mathematics tubes are filled with "mathematics games and puzzles, two or more different kinds of manipulative such as number cubes or tan grams and mathematics challenges questions which required no materials but creative brain power.

Statement of the Problem

Mathematics plays an important role in our everyday life. For this reason, the national education system plan (1971-1976) has emphasized in making the

mathematics teaching life oriented and practical. Most of the schools in Nepal are still using the traditional methods characterized by mastery of subject matter through drill repetition and memorization. The subject matter is presented with limited teaching aids. Without the use of necessary aids, the teacher remains unable to make the mathematics teaching practical and effective. The student's practically small children at lower secondary level, find it difficult to understand mathematics practically. Hence, this study intends to study on effects of manipulative materials in teaching mathematics, at lower secondary level. Therefore, this study has focused on the answer to the following question:

- Dose the use of manipulative materials effect in teaching mathematics ?
- The use of manipulative materials yield better achievement of students than without using manipulative materials in mathematics ?

Objective of the Study

To find at the solution, results of the statements of problems of the research, the researcher has formulated the following objectives.

- To compare the achievement of the students that are taught by using manipulative materials and thaught to the students without using manipulative materials in mathematics.
- To find out the effect of the manipulative materials in teaching mathematics at class VI.

Significance of Study

This study would be helpful for teaching mathematical concepts and it will always encourage the teachers teaching in lower secondary level to use teaching

materials. This study would provide the guideline to educators, researchers and curriculum planners. To improve quality of education use of instructional materials is one of the most essential factors. It plays a vital role in developing mathematical conception students and helps them to get a roadmap from different obstacles. Most of the teacher at lower secondary level does not have proper knowledge about instructional materials and their uses. Students cannot understand the different mathematics concepts, ideas properly. This study is essential to identify the effect of manipulative materials in teaching mathematics concepts at lower secondary level . It also helps to improve the understanding of students and enables the mathematics teachers to use appropriate materials. This study will also help the teachers, students, textbooks writers to choose appropriate instructional materials according to the subject matter. Hence the significances of the study as follows.

- This study could help to find out the effect of manipulative materials in teaching Mathematics.

- This study would help those personal who are looking forward to get better result in mathematics by teaching concept and content.

- The result of this study should be help teacher, trainers, educators and writer too.

Statement of Hypothesis

The study would attempt to seek the result of the following research hypothesis and statistical hypothesis.

Research Hypothesis

The mean achievement of the students taught by using manipulative materials is better than mean achievement of the students are taught without using manipulative materials in teaching mathematics.

Statistical Hypothesis

The null and alternative hypothesis formulated as,

- H_0: There is no significance difference between the mean achievement score of experimental and control groups i.e. $\mu_{1} = \mu_2$ on pre-test.

- H_1 : the mean achievement score of experimental group is not equal to the control group i.e. $\mu_1 \neq \mu_2$ on pre-test.

- H_0: there is no significance difference between the mean achievement score of experimental and control groups i.e. . $\mu_{1} = \mu_2$ on post-test.

  H_1 : The mean achievement score of experimental group is higher than the control group i.e. . $\mu_{1>} \mu_{2}$.

  where μ_{1} and μ_2 are mean achievement scores of students taught by using manipulative materials and without using manipulative materials in teaching mathematics respectively.

Delimitation of the Study

This study would be delimited under the research due to time constraints, economic constraints, facility, rule and regulation of research the researcher has limited as followings.

- The researcher of this study has utilized manipulative materials (piece of bamboo, ruler, and rectangular pieces of paper) particularly teaching of intersecting, parallel and perpendicular lines to the grade VI students.

- This study would be conduct in Siraha district at public school.

- Based on the sample selected from Grade VI and 15/15 students of Lower secondary level.

- Public school would be selected as experimental and control group. The experimental group and control group were determined by tossing a coin.

- The study would be an experiment for the duration of 30 days.

- The content coverage would be limited arithmetic portion of grade six in menstruation.

- The sample would be selected from students of different two government school in Siraha district.

Definition of Related Terms

In every research some important terms. So there used same terms are defined below.

Achievement: In this study, the term "achievement" is defined in terms of the scores obtained by the students on an achievement test prepared by the teacher.

Public School: Public school is that which receive the government grant for the salary of teacher and other educational purpose.

Control group: The group who had given regular instruction in mathematics without using manipulative materials.

Experimental group: A group of students who had provided manipulative materials regularly in teaching mathematics.

Manipulative materials: Educational materials that are designed to be touched or handled by students and which develop their perceptual skills, psychomotor skills etc are called manipulative materials. While teaching mathematic researcher was used rope, cube, dice, ruler, compass, desk, bottle, ball, solid figure, square figure, sticks and cut-out shapes,

CHAPTER -II

REVIEW OF RELATED LITERATURE

A review of literature is the process of locating, obtain, reading and evaluating. It is the source of further study of research task. The review of literature provides the researcher in making his/ her problem more realistic ,precise ,researchable and meaningful. It helps to conduct the research program and gives a better idea of surveying and research. Then it guides towards conclusion. Thus ,the review of literature is an important and essential guideline of research planning. This chapter deals with the study of the literature related to this study.

Empirical Review of Literatures

Many studies have been conducted about teaching methods , teaching problems ,faced by the teachers , instructional materials and student's achievement in mathematics in   different grades in school level. So far as the researchers is concerned ,there is not exactly same research has been done on the effectiveness manipulative material in learning mathematics as lower secondary level. The researcher has tried to find out the literatures related to identification and analysis if errors committed by the students. Some of them are illustrate as follows :

Karki (2010) had done research on " A study on the effectiveness of instructional material in teaching Geometry at grade ten. HE found that the mean achievement score of students taught with using different instructional materials in higher than the mean achievement score of students taught without using different instructional materials Using different instructional materials causes better achievement than the teaching without using instructional materials.

Chaudhary (2011) studied on "Effectiveness of instructional material on teaching menstruation at secondary level. He found that achievement of the grade ten students who were taught Menstruation with using different instructional materials achieved better achievement than the students who were taught without using instructional materials .

Regmi (2006) did research work on "Effectiveness of instructional material (OHP) in teaching geometry at secondary level. His research concluded that the experimental groups were positively very high from the different analysis and statistical calculation. It is concluded that among all the instructional materials (OHP) should be an integral part of the teaching mathematics.

Kafle (2010) studied on "A study on the effectiveness of instructional materials in teaching transformation Geometry. The result of the study indicate that the average achievement score of students taught with using various instructional material is higher than the average achievement of students taught without using instructional materials.

Upadhyay (2010) had investigated or ' A study on effectiveness of instructional materials in teaching mathematics of lower secondary level. Researcher found that the achievement of the grade -viii students taught by using instructional materials were significantly greater than the mean score of the achievement of the students taught without using instructional materials.

Gautam (2005) did a research entitle "Effectiveness of instructional materials in teaching menstruation at secondary level" with the objective to find the effectiveness of instructional materials in teaching maturation at secondary level mathematics and to compare the mathematical achievement of boys and girls in the

topic menstruation taught by using instructional materials. He concluded that the students of experimental group performed better than the student of control group. Also, it was concluded that the boys and girls of experimental group are equally benefited by the instructional materials exposed to them.

Pandey (2007) had done an experimental research on "Use of visual aids in teaching fractions". The main target of his study was to develop teaching models for the teaching of fractions in grade vi. His ultimate conclusion shows that the teaching model with visual aids was found to be more effective then the plain verbal expository mode.

Dhakal (2010) did a researcher on " Effectiveness of Van Hiele model of learning geometry at primary level". He took the simple of 30 students of Harvard Academy, Pokhara. He divided the sample students into two groups experimental and control. He used traditional method for the control group and Van Hiele model for the experimental group. After the completion of the teaching, he conducted a post achievement test and tested t-scores for both groups . He found that the achievements score of experimental group was better.

 Amtya (1978) did a research on " A study of the effectiveness of teaching mathematics with and without the use of instructional materials" under the supervision of Prof. S.K Shrestha with the aims of find out whether instructional materials are helpful to develop the mathematical concepts and to measure the difference in concept development among students from Lalitpur Nagar Panchayat were selected by using systematic sampling and the experiment was conducted for four weeks duration. The t-test was applied to conclude that the mean difference was significant at 0.05 levels. The conclusion was that the performance of student taught

with the use of instructional materials was significant improved when compared with the performance of the students taught without the use of instructional materials.
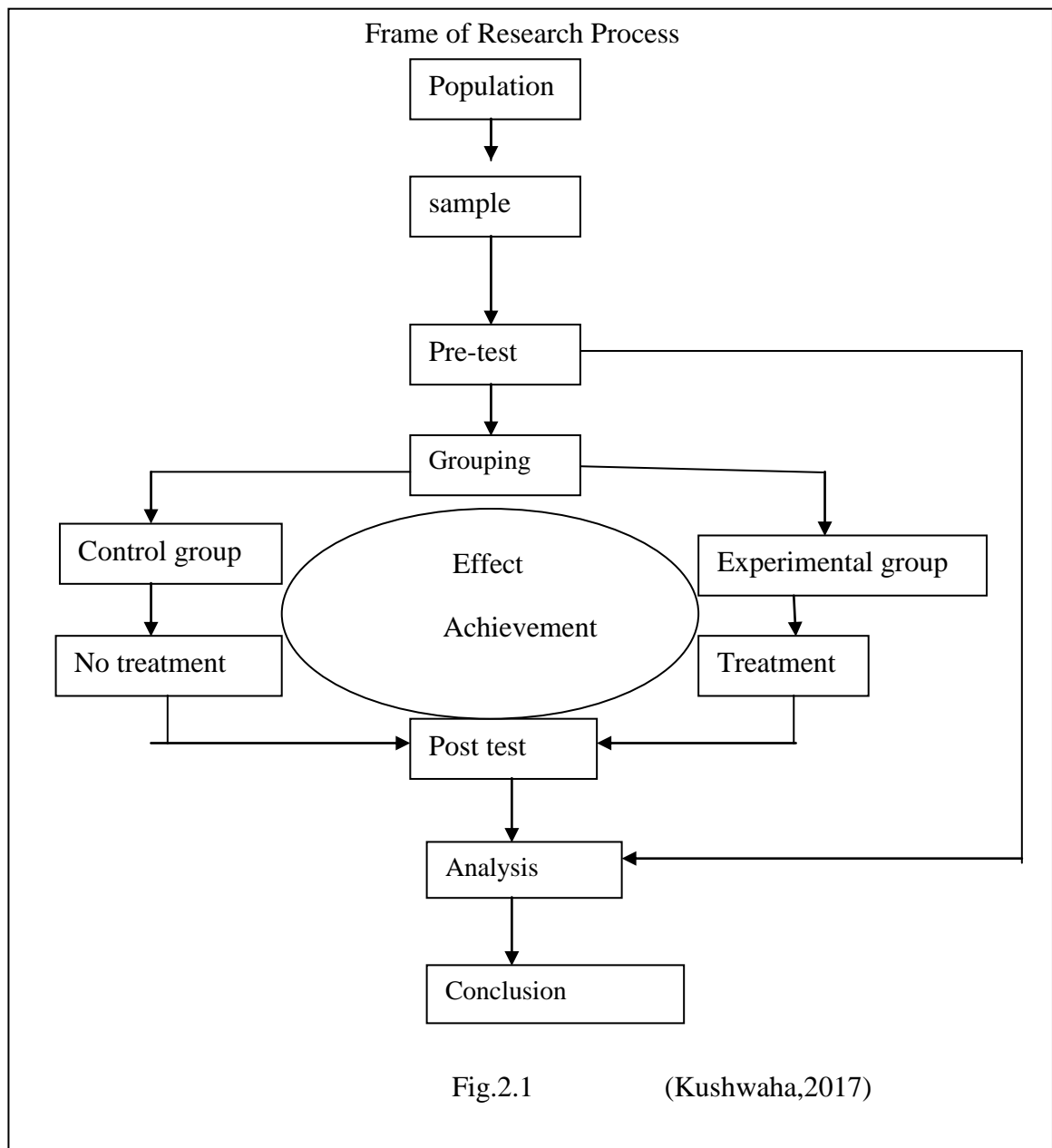
After analyzing and revising above students, the researcher arrives at the conclusion that the research study would be fruitful to find the higher achievement of lower secondary level Grade XI students in mathematics teaching with using manipulative materials then without using manipulative materials.

Theoretical Review

Manipulative are instruction materials which facilitate teaching and learning and make positive contributions to conceptualization and interpretation processes of students. However, manipulative do not only contribute to the cognitive aspect of the learner, they also enhance the development of psychomotor by addressing several senses of the learner such as sight, touch or hearing inside and outside the class. As stated manipulative should not be thought of as a remedy providing an advantage against every difficulty that students face in mathematics. Instead as underlined teachers and students need to make a common sense out of the manipulative they are use. Otherwise, manipulative would not go beyond being a means of entertainment alone and cannot help the learner to comprehend any concepts. That is why, it was emphasized in many studies that manipulative should be understood and applied properly especially during the teaching-learning process. The manipulative would go beyond being instruments of play and entertainment from the perspective of the students and would be transformed into materials contributing to their learning.

Procedural Framework

The procedural framework of this study as follows:

Frame of Research Process

Population

↓

sample

↓

Pre-test

↓

Grouping

Control group   Effect   Experimental group

Achievement

No treatment   Treatment

Post test

↓

Analysis

↓

Conclusion

Fig.2.1   (Kushwaha,2017)

The main purpose of this research is specifying effect of manipulative material teaching and learning mathematics. Thirty students will be selected a sample from random sampling method. This group is divided in two groups having each group fifteen students. Pre-test is given for all thirty students. After grouping experimental and control group, experimental group practicing manipulative material as treatment. Then post-test given to all students for analysis and conclusion.

CHAPTER III

METHOD AND PROCEDURES

This chapter has designed for describing the methods and procedures. It includes the description of the research design, population and sample, sampling procedure, data collection tools, data collection procedure and analysis procedure of the collected data.

Design of the Study

The pre-test, post-test non equivalent group designed would be adopted for the purpose of this study. The paradigm of the study is as follows:

Table no.1

Group	Pre-test	Treatment	Post-test
E	T_1	T	T_2
C	T_1	-	T_2

where   E = Experimental group

C = Control groups

T = Treatment

T_1 = Pre-test

T_2 = Post-test

This design is one of the most effective in minimizing the threats to experimental validity. Two groups will made homogeneous as possible on the basis of pre-test result . After establishment of two equivalent groups E and C, experimental group received for the experimental treatment (T) where as control group was not. Treatment group was taught by manipulated materials. After that, post -test had given to students for data collection and data will be analyzed for the result of research.

Population of the Study

The population of the study was from grade VI students of Siraha district of lower secondary level.

Sample of Study

The researcher had selected Public School Shree Sundar Janta Secondary School Aurahi and Shree Lower Secondary School Tenuwapatti of Siraha District. Thirty students of grade VI of this school as the sample of the study. These students have selected after given pre-test exam, by random sampling. From Shree Sundar Janta   Secondary School Aurahi students are selected as experimental group and from Shree Lower Secondary School Tenuwapatti students are selected as control group Each groups have 15 students.

Two groups of students were found homogeneous as possible as by selecting school of similar status and focusing same cognitive structure of students by touching the coin.

Data Collection Tools

To find the effect of using manipulative materials, so students had chosen whereas the same teacher had teach both the group one by using manipulative materials and other without using manipulative materials. The main tool for the data collection was achievement test. Pre-test and post-test had given to the students. Both tests contain appropriate subjective and objective type questions. Furthermore, test paper collected and test items has subjected to the item analysis.

Reliability and Validity of Test

To ensure the good quality of the test (tool),validity was more important what is means that the test most have the test items which truly assess the skill and abilities as indicated by given learning out comes. Validity of the achievement test and questionnaire was established by the help of subject teacher, expert and supervisor.

Reliability of the test was every important of the study. For this purpose , every test items were piloted and reliability was checked before it was administered to 46 Students enrolled in grade VI of Shree Sundra Janta Secondary School. Before administering the test paper, the researcher instructed the students how to respond the test paper, time taken by each students was recorded. The reliability of the test was established by using split half method. The split half reliability coefficient is 0.81 is given in Appendix B.

Data Collection Procedure

The procedures of data collection indicate how the relevant data has gathered. The study is manly base on quantitative data obtains from achievement test. For this, researcher was met school administration, subject teacher and take permission for test

in selected school. Before given to test, students are informed for response. After collecting and scoring all the answer sheets, the scores had tabulated. After that thirty students selected for experiment as mentioned in sampling method. Then manipulative materials used as an intervention treatment for the experimental group.

Academic performance test used as a pretest and posttest for the experimental as well as control groups to assess the effect of manipulative on the mathematics achievement of the experimental group and to compare it with the control group, who never taught by manipulative materials.

Data Analysis Procedures

An Experimental Method used to know the effect of Independent Variable for this study. In this Method, experimental simple equivalent group pre-test, post-test experiment design introduce for entire study. With the help of both groups' pre and post-test's score, data will be analyze and interpret by using following statistical procedures.

- Mean, Standard deviation and Variance has calculated for both groups with their secured marks in the test.

- Correlation co-efficient between experimental and control group has determined.

- T-test has used to investigate the significant difference between the achievements of two groups of sample students.

CHAPTER -IV

ANALYSIS AND INTERPRETATION

Introduction

This is an experiment study. The main focus of this study is to explore the effectiveness of the manipulative materials on teaching mathematics at lower secondary level. The main parameter to explore the effectiveness of teaching approach is performance achievement of the students. For this purpose, achievement of lower secondary level students in collected . The statical analysis of the obtained data has been presented in this chapter. The data of the achievement test scores are analyzed under the following healings.

- Comparison of mean achievement scores of control group and experimental group for pretest data.

- Comparison of mean achievement scores of control group and experimental group for posttest data.

- Comparative bar graph showing mean achievement scores of experimental and control groups for the pretest and post-test.

- Comparison of mean achievement scores of experimental and control group on pre-test.

    Scores of the pre-test of students of experimental and control group have been given in Appendix E-1 together with the statically calculation of mean, variance and standard deviation of mean achievement scores of pre-test has been presented in

table-2.

Table-2

Mean, SD and variance of pre-test result

Group	N	Mean	SD	Variance	t-value	$\propto$
E	15	15.6	2.33	5.43	0.19	0.05
C	15	15.8	3.28	10.82		

t 0.025,14=2.14

The mean achievement of both groups were composed statistically using t-test with two tailed of 0.05 level of significance. It was found that the calculated t-value of 0.05 is 0.19 which is less than the table value i.e 2.14 with degree of freedom 14 (N-1). The research used the t-test for unequal variance . There for, null hypothesis is accepted hence there is no significance difference between mean achievement scores of E group and C group on pre-test.

Comparison of mean achievement scores of experimental and control group on post-test . The post-test was administered to both experimental and control groups after the treatment. The post-test scores of students of experimental and control group have been presented in Appendix E-2. The calculation of mean, standard deviation and variance, correlation have also been made to calculate t-value as mentioned in Appendix E-2. The summary of t-test analysis for the comparison of mean scored of experimental and control group have been given in table-3.

Table-3

Mean, SD, variance, correlation and t-value of post test

Group	N	Mean	SD	Variance	t-value	∝
E	15	33.53	4.34	18.91	5.08	0.05
C	15	26.46	3.17	10.11		

t 0.025,14=2.14

Above table indicated that both means and standard deviation are different. The scores of experimental group ranged from 41 to 26 with the mean scores 33.53 and control group ranged from 31 to 20 with the mean score 26.46, also SD are 4.34 and 3.17 respectively. The different in the mean achievement between experiment group and control group in found to be 7.07. The test analysis indicates that the different in mean are found significant at 0.05 levels. The calculated t-value is 5.08 which is greater than tabulated value 2.14 so the result does not support the null hypothesis that then is no significance difference between mean achievement scores of experimental and control group on post-test scores rather it supports alternative hypothesis of their existence of the difference (in favor of experimental group) analysis of the pre-test scores indicated that the groups were comparable of ∝= 0.05 level of signiicance . So, the better performance of experimental group over control group on the post-test scores might have been attributed due to new treatment given to experimental group.

Comparative Bar graph of pretest and post test

In addition to the advance statistic, data are presented in visual form to understand the result/difference more effectively.
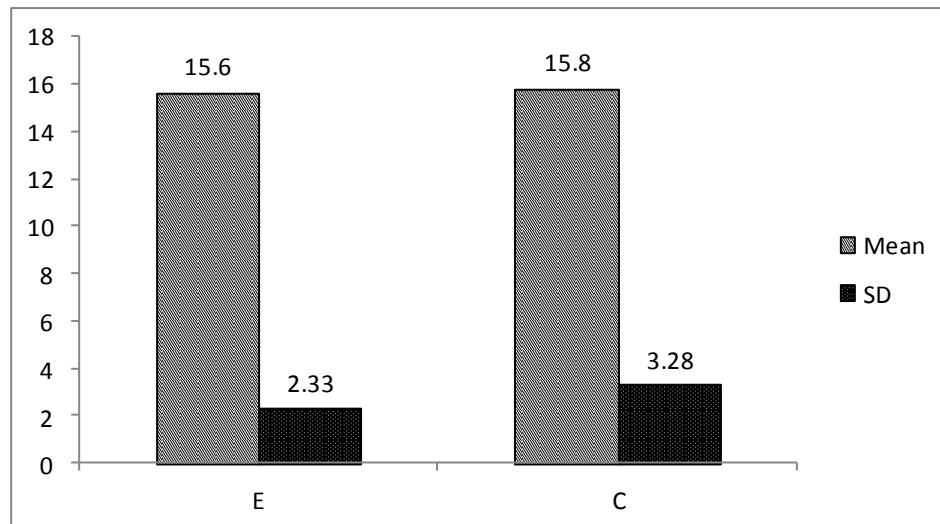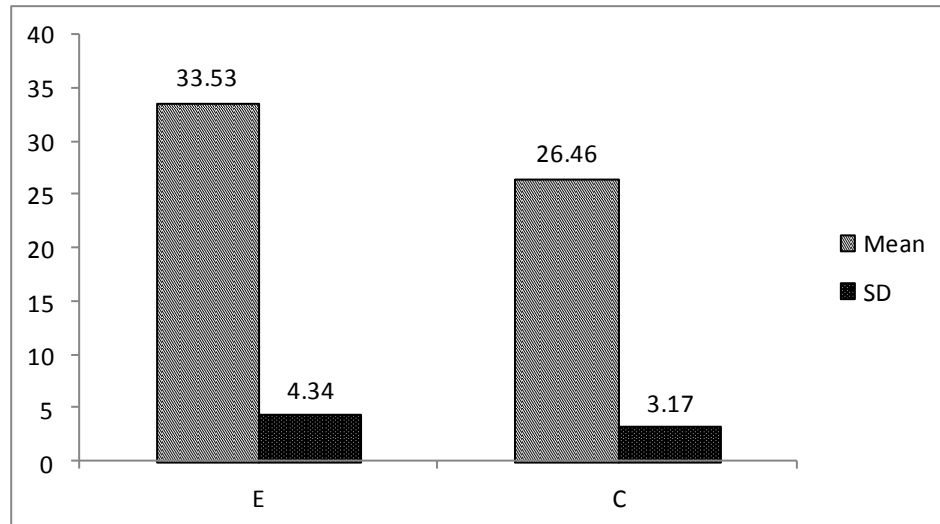

Figure 4.1: Mean score and SD distribution of pre-test

The Figure Shows that the mean score and SD of experimental group is 15.6 and 2.33 respectively. Similarly, mean score and SD of Control group is 15.8 and 3.28 respectively. Similarly mean score and SD of control group in 15.8 and 3.28 respectively. The difference between mean is 0.2, which shows that these both group experimental and control are nearly equal. Hence, there is no difference is achievement scores in mathematics between experimental and control group of students.

Figure-4.2: Mean, score and SD distribution of post test

The Figure Shows that mean score and SD of Experimental group is 33.53 and 4.34 respectively. Similarly, mean score and SD of control group is 26.46 and 3.17 respectively. The difference between mean is 7.07, which shows that there is great impact on experiment group teaching by using manipulative material. More than control group given in Appendix E-2. Shows improves the achievement of Students.

Exercise to Control the Extraneous Variable

- The following exercise had alone to control the effect of extraneous variables.

- Subject matter: same subject matter was present in class room learning.

- Evaluation Applied: same test had provided on both groups (control and experimental) at pre-test and post test.

- Students: Students are regular and not taking the extra or tution class and physical exercise.

- Teacher: Same class teacher has taken classroom teaching on both group.

CHAPTER-V

SUMMARY, FINDINGS & CONCLUSION AND RECOMMENDATIONS

As stated in the introduction, the purpose of this Study was to test the effectiveness of the use of manipulative materials in teaching at lower secondary level. In this chapter summary, Findings Conclusion and recommendations for further study have been presented under the following heads.

Summary

Since mathematics as the science of abstract form and its importance is ever increasing. Mathematics took place as a compulsory subject from elementary level, as its relation with a different discipline. There are different areas on mathematics. Only selected topics were taught on VI grade mathematics.

Mathematics learning achievement directly affected by some independent variables. It may be teaching methods textbook, parent's education, instructional materials, socio economic condition, school, teacher qualification, etc. This research directly motive to see the affect of independent variables manipulative materials over dependent variables student achievement.

The researcher kept all independent variables as silent except materials. The main question over this research were to see, is there a effectiveness of manipulative materials on teaching of grade six math . Does achievement differ significantly When manipulative materials are used? Over these research questions, this study has been done on Siraha district. The desired Objectives of this research study were; to identify the effectiveness of manipulative materials on teaching at lower secondary level and to compare the achievement between the use of materials and without materials.

This study gives an evidence of the effectiveness of manipulative materials in teaching. It is also significance that it helps to provide the concerned personnel mathematics and agencies to use the appropriate materials on teaching at lower secondary level.

The study was experimental, in order to conduct the experimental study on the effectiveness of manipulative materials in teaching menstruation at lower secondary level, the researcher developed a teaching module and taught by him. Student of experimental group using manipulative materials and taught by him. Student of experimental group using manipulative materials and taught the students control group using conventional teaching method. At the end of teaching a standardized achievement test was administered on both the groups. The pre test, post tests control, equivalent groups design were adopted for the purpose of the study. Mean, S.D. and variance were calculated in both groups with their obtain marks. T-test was used at 0.05 level of significance to find whether the different of means spastically significant. The scores obtained by the students in the test was analyzed and thus had the following findings;

Findings of the study

The finding's were expressed here of students on the basis of the analysis of the data obtained from the achievements test ,which has been described in chapter IV. Accepting or rejecting the significance of null hypotheses constant for the study determined the effect of manipulative materials as compared without using manipulative materials and questionnaire related to likart scale constructed for the analyzing students view on manipulative materials in teaching mathematic at grade VI. The finding of study were observed from the calculated and tabulated t-value

recorded in table for hypotheses to achieve the objectives of the study. It was found that the mean score of the students of experimental groups was greater than the mean score of the students of control group. statically the difference between the mean scores was significant. Also mean and standard derivation recorded in table for analyse students view on manipulative materials.

Conclusions

On the basis of the finding of the data analysis the researcher concluded that the use of manipulative materials was effective in teaching at lower secondary level for mathematics. Students in the experimental groups performed better in the post-test compared to the control group. Students generally gave positive feedback or view about the manipulative materials in learning mathematics. Also manipulative materials was essential and important for the teaching mathematics.

Recommendations

On the basis of finding of this study some measures have been recommended for the improvement of the teaching situation in lower secondary classes as given below.

- Analysing the teachers view on manipulative materials in teaching mathematics.
- Mostly the math teacher should try to use available materials in teaching mathematics.
- The mathematics teacher should be encouraged to use manipulative materials in teaching mathematics.
- The mathematics book should emphasize on the using of materials.

- To study on 'How does using manipulative materials effect students' achievement towards mathematics learning?

- Training programme should priority the using of materials.

References

Amatya, B.P. (1978). *A Comparative Study of the Teaching Mathematics with and without the use of Instructional materials.* M.Ed. Thesis, Central Department of Mathematics Education, T.U., Kathmandu.

Balka, D. S. (1993). *Making the connections in mathematics via manipulatives. Contemporary Education,*

Boggan, M., Harper, S., & Whitmire, A. (2010*). Using manipulatives to teach elementary mathematics. Journal of Instructional Pedagogies,*

Cass, M., Cates, D., & Smith, M. (2003*). Effects of manipulative instruction on solving area and perimeter problems by students with learning disabilities. Learning Disabilities Research & Practice*

Chaudhary, B.C.(2011). *Effectiveness of instructional materials on teaching menstruation of secondary level.* M.Ed. Thesis, Central Department of Mathematics Education, T.U., Kathmandu.

Cope, L. (Spring 2015). *Math manipulative: Making the abstract tangible. Delta Journal of Education.*

Dhakal ,O.P.(2010*). Effectiveness of Van-Hielemodel of learning geometry at primary level.* An unpublished M.Ed. thesis, TU , Kathmandu.

Gautam, D. (2005). *Effectiveness of Instructional materials in Teaching Menstruation Secondary Level.* M.Ed. Thesis, Central Department of Mathematics Education, T.U., Kathmandu.

Kafle,s.(2010). *A study on the effectiveness of instructional materials in teaching transformation geometry at grade ix.* M.Ed. Thesis, Central Department of Mathematics Education, T.U., Kathmandu.

Karki,K. (2010) . *A study on the effectiveness of instructional materials in teaching geometry at grade x.* M.Ed. Thesis, Central Department of Mathematics Education, T.U., Kathmandu.

Pandey, Kamal (2005). *A Study on use of Instructional Materials and Its Impact in Teaching Mathematics in Primary Level.* M.Ed. Thesis, Central Department of Mathematics Education, T.U., Kathmandu.

Regmi, G (2006) . *Effectiveness of instructional materials (OHP) in teaching geometry at Secondary level* .M.Ed. Thesis, Central Department of Mathematics Education, T.U., Kathmandu.

Shrestha, S.H (2010). *Effectiveness of instructional material in teaching trigonometry of secondary level* . M.Ed. Thesis, Central Department of Mathematics Education, T.U., Kathmandu.

Shrestha,N.R (2016). *Effectiveness of instructional materials in teaching menstruation at secondary level.* M.Ed. Thesis, Central Department of Mathematics Education, T.U., Kathmandu.

Upadhyay, N.R.(2010). *A study on effectiveness of instructional material in teaching mathematics at lower secondary level.* M.Ed. Thesis, Central Department of Mathematics Education, T.U., Kathmandu.

Pre – Test Question

कक्षा : ६

विषय: गणित   पूर्णाङ्क : ५०

समय: १:३० घण्टा   उर्त्तीणाङ्क : २०

प्र.न.१ रेखा को परिभाषा उल्लेख गर्नुहोस ? ५

प्र.न.२ समानान्तर रेखा र लम्ब रेखाहरुको उदाहरण देखाउनुहोस ? (२.५+२.५) = ५

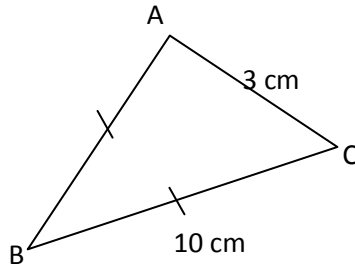प्र.न.३ कोणको प्रकारहरु लेखनुहोस ? ४५$^\circ$ र ६०$^\circ$ को कोणहरु रचना गरेर देखाउनुहोस ?

   २+३ = ५

प्र.न.४. भुजाका आधारमा त्रिभुजको वर्गीकरण गर्नुहोस र प्रत्येकको नामाकरण गर्नुहोस ?

प्र.न.५. कापिमा ग्राफ कोरी X अक्ष र Y अक्षमा दिएका विन्दुहरु भर्नुहोस ?(0-2)(-1,3),

   (3,-3) ५

प्र.न.६. त्रिभुजको परिमिति भनेको के हो ? दिएको चित्रबाट त्रिभुजको परिमिति

   निकाल्नुहोस । ? २+३ = ५

प्र.न.७. स्थानान्तरण Transformation भनेको के हो ?

प्र.न.८. समूह भनेको के हो ? दुईवटा समूहहरुको उदाहरण उल्लेख गर्नुहोस ?

   (२+१.५+१.५) = ५

प्र.न. ९. तलको कुन कुन समूह हो छुट्टाउनुहोस र नाम उल्लेख गर्नुहोस ।

(क) A = {a,b,c,d }   (ख) A= {   }

   B = {1,2,3,4}

(ग) { 1,3,5,7 ......}

प्र.न.१०. तलका भिन्न जोड र दशमलव जोड गरेर देखाउनुहोस ।

(क) $\frac{3}{2} + \frac{6}{3}$ (ख) $\frac{1}{2} + \frac{3}{2} + \frac{5}{4}$

(ग) 3.456+23.901   (घ) 0.506 + 3.052   (ङ) 0.052+21.032

Post-test Question

कक्षा : ६

विषय: गणित   पूर्णाङ्क : ५०

समय: १:३० घण्टा   उर्त्तीणाङ्क : २०

प्र.न.१. रेखा भनेको के हो ? समानान्तर रेखा र लम्ब रेखाको उदाहरण दिनुहोस ।   ५

प्र.न.२. समकोण र न्यूनकोण भनेको के हो ? सेटबक्स प्रयोग गरी ७५$^\circ$, ९०$^\circ$ र १२०$^\circ$ को
    कोणहरु रचना गरेर देखाउनुहोस ।   ५

प्र.न.३. त्रिभुज (Prism) चतुर्भुज (Quadrilateral)को परिभाष दिनुहोस ।उदाहरण सहीत
    उल्लेख गर्नुहोस ।   ५

प्र.न.४ .ग्राफ पेपरमा ह- अक्ष र थ-अक्षमा ० देखी १० सम्मको संख्याहरु राखेर तलका
    विन्दुहरु भर्नुहोस । (०, २), (३,०) , (४,६) (६,४) (९,६) , (७,८) ………….   ५

प्र.न.५. वर्ग भनेको के हो ? तल दिएको चित्रमा छाया पारिएको भागको क्षेत्रफल कति
    होला ?   ५

```
1.5 cm   1 cm    1.5 cm
┌─────┬──┬─────┐
│     │  │     │ 2 cm
│     └──┤1 cm │
│     ┌──┤     │
│  ── │  │     │
│ 2 cm├──┤     │
│     │┬ │     │
└─────┴──┴─────┘
1.5 cm   1 cm   1.5 cm
```
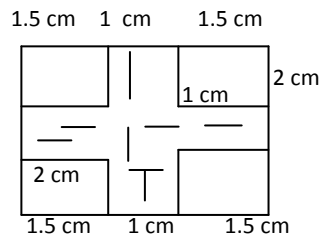
प्र.न.६. षडमुखको आयतन निकाल्ने सूत्र लेख ? त्रिभुजको परिभाषा उल्लेख गर्नुहोस । ५

प्र.न.७. स्थानान्तरण (Transformation) भनेको के हो ?दिएको चित्रलाई विपरित अक्षमा स्थानान्तरण गर्नुहोस ।   ५

x   (2,4)
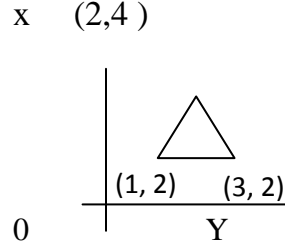
प्र.न.८. समूहको परिचय दिनुहोस ? ३,६,९,११,१२ मध्ये एउटालाई क्रस (✕) गर, त्यसपछि बाँकी के को समूह बन्छ, लेखनुहोस ।   ५

प्र.न. ९. समतुल्य र (Equivalent) र बराबर (Equal) समूहहरुको परिचय र उदाहरण सहित उल्लेख गर्नुहोस ।   ५

प्र.न.१०. तलका भिन्न घटाउ र जोड गर ।   ५

(क) $\frac{3}{2} - \frac{4}{6}$ (ख) $\frac{3}{4} - \frac{3}{6} - \frac{2}{2}$ (ग) $\frac{4}{5} + \frac{7}{10}$ (घ) $\frac{6}{2} + \frac{3}{4} + \frac{1}{6}$

Teaching Episode-1

Topic: Intersecting, parallel and perpendicular lines

Objectives: To enable students to.

- ➢ separate intersecting lines.

- ➢ Separate Parallel lines

- ➢ Separate perpendicular lines

Manipulative materials:

- ➢ Ruler

- ➢ Rectangular pieces of paper

- ➢ Difference solids figures

- ➢ pieces of Bamboo.

Performance:

Explain to the students about intersecting lines with the help of pencils, fingers and pieces of bamboo.

- ➢ Discuss with students through pieces of bamboo, rectangular pieces of paper about parallel lines.

- ➢ The students will be asked the show intersecting, parallel lines with the help of pencils, bamboo's pieces etc.

➢ With the help of solids figure students can understand the condition of perpendicular lines. They can seen different perpendicular lines through pencils Individual work: Show intersecting, parallel, perpendicular lines with the help of pieces of bamboo.

Homework: The student will be asked name the condition of lines.

a)   b)   c)

d)   e)   f)
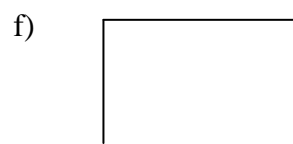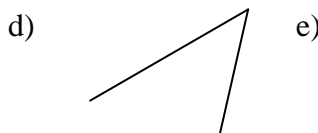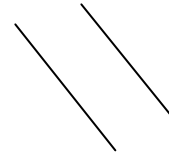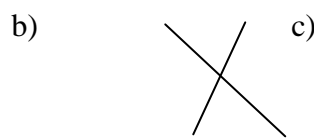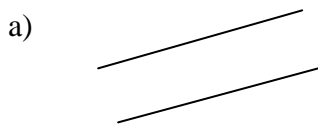
Teaching Episode-2

Topic: polygons

Objective: To enable student know the different polygons.

Manipulative Materials: Sticks of Match, sticks of wood, different model of polygons.

Performance:

➢ Making different polygons with the help of sticks of Match and wood and show to the students.

➢ The students will be asked to construct the different polygons with the help of sticks .

➢ Discussing different figure of polygons which is seen in home, school, bridge etc.

Individual work at class: Construct triangle, rectangle, square, pentagon, hexagon, heptagon octagon etc.

Homework: Write different polygon which you have seen in home schools.

Teaching Episode-3

Topic: Perimeter of Triangle

Objectives: To enable students to

> ➤ Find the perimeter of triangle figures.

> ➤ Know the method of finding perimeter.

Manipulative Materials: Different size of bamboo sticks and triangles module.

Performance: The students will be asked to make triangle of different shape with the help of sticks and to measure the sides of each figure.

> ➤ Write the /measure of each sides of different in your copy.

> ➤ After, that, explain to the student about the concept of perimeter. The perimeter of a shape or figure in the distance around the figure.

Individual Work at class: i) Add all the sides of figures which you have measured .

Homework: Find the perimeter of these shapes.

Star figure labels: 4 cm, 3.5cm, 4 cm, 4.8 cm, 3cm, 4.8 cm, 4cm, 4 cm, 3.5 cm, 4 cm

L-shape figure labels: 2 cm, 2 .5cm, 3 cm, 2 .5cm, 4 cm, 2.5 cm, 15 cm
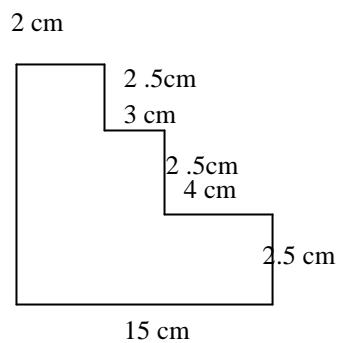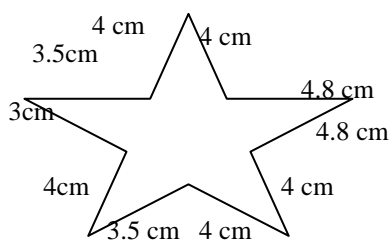
Teaching Episode-4

Topic: Area

Objective: To enable student to calculate or determine the area of triangle.

Manipulative: Materials Square figures, rectangular figures, and solids figures.

Performance: To shows different solids figure, regular polygons and different shape which is exist in daily life too. The student will be asked to measure the each sides of different figure. And, Area can be defined as the amount of space inside the boundary of a flat object such as square, Rectangle etc as shown below.

1	2	3	4	5	6	7	8	9	10

Area=10cm^2

1	2	3	4
5	6	7	8
9	10	11	12

Area=12cm^2

Individual class work: Find the area of these shapes.

7cm

3 cm

4 cm

3 cm

38
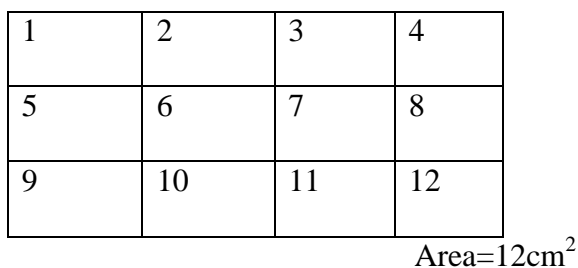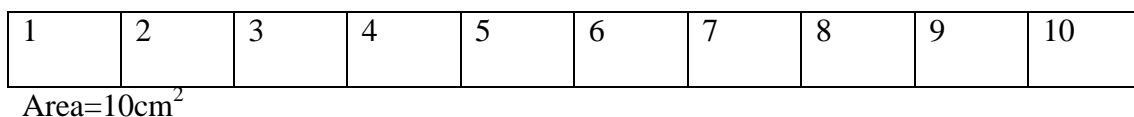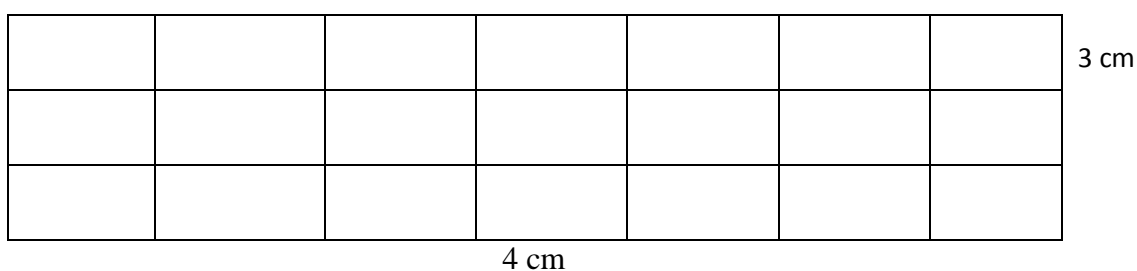
Teaching Episode-5

Topic: Volume of solid

Objectives: To enable students to

- ➤ Recognize three dimensional objects .

- ➤ Determine the volume of a solid cube and cuboid.

Manipulative materials: Different solids figures (Match Boxes, bulb boxes, Bottle,

ball etc.)

Performance: The objects shown on the given below will be places in the table and students will be asked to name the objects.

Explaining the students as shown below :

Volume will be defined to the students by filling some shapes like a juice can a cylinder or a lunch box (a cuboids) with water. The amount of water which either shape will hold can be poured into a measuring cylinder to find the volume.
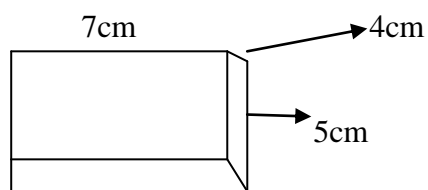
The formula for calculating the volume will be explained.
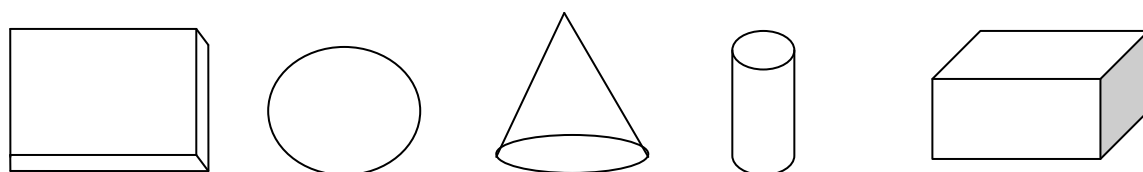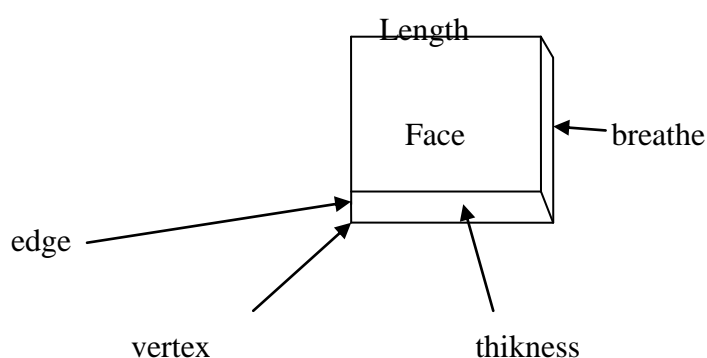
- volume(v)= length x breadth x height

- Volume of cube is (l=b=h) cm^3

Individual class work: Measure the given solids figure and find volume.

Home work: Find the volume of the following shapes using the formulae.

7cm   →4cm

5cm

3cm
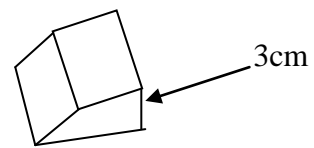
Teaching Episode-6

Topic: Intersecting, parallel and perpendicular lines
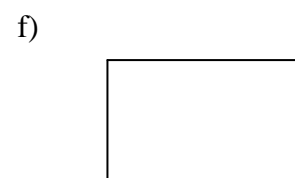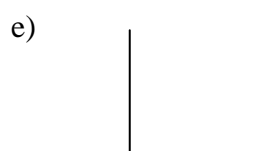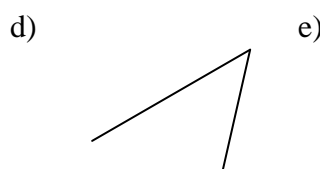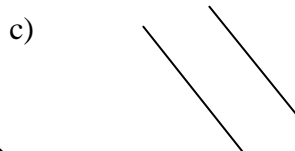
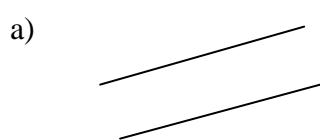Objectives: To enable students to.

> ➢ separate intersecting lines.

> ➢ Separate Parallel lines

> ➢ Separate perpendicular lines

Performance:

Explain to the students about intersecting lines with the help of pencils, fingers and pieces of bamboo.

➢ Discuss with students through pieces of bamboo, rectangular pieces of paper about parallel lines.

➢ The students will be asked the show intersecting, parallel lines with the help of pencils, bamboo's pieces etc.

➢ With the help of solids figure students can understand the condition of perpendicular lines. They can seen different perpendicular lines through pencils Individual work: Show intersecting, parallel, perpendicular lines with the help of pieces of bamboo.

Homework: The student will be asked name the condition of lines.

a)   b)   c)

d)   e)   f)

Teaching Episode-7

Topic: polygons

Objective: To enable student know the different polygons.

Performance:

> ➢ Making different polygons with the help of sticks of Match and wood and show to the students.

> ➢ The students will be asked to construct the different polygons with the help of sticks .

> ➢ Discussing different figure of polygons which is seen in home, school, bridge etc.

Individual work at class: Construct triangle, rectangle, square, pentagon, hexagon, heptagon octagon etc.

Homework: Write different polygon which you have seen in home schools.

Teaching Episode-8

Topic: Perimeter of Triangle
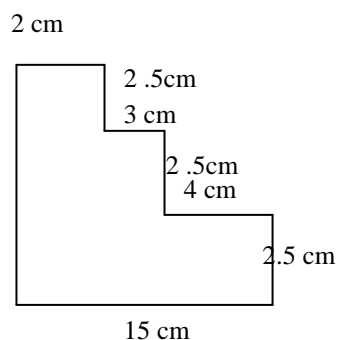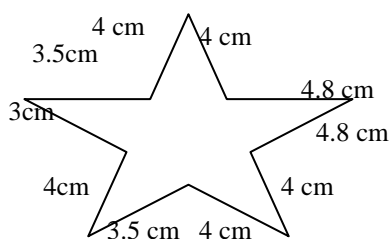
Objectives: To enable students to

> ➢ Find the perimeter of triangle figures.

> ➢ Know the method of finding perimeter.

Performance: The students will be asked to make triangle of different shape with the help of sticks and to measure the sides of each figure.

> ➢ Write the /measure of each sides of different in your copy.

> ➢ After, that, explain to the student about the concept of perimeter. The perimeter of a shape or figure in the distance around the figure.

Individual Work at class: i) Add all the sides of figures which you have measured .

Homework: Find the perimeter of these shapes.

Teaching Episode-9

Topic: Area

Objective: To enable student to calculate or determine the area of triangle.

Performance: To shows different solids figure, regular polygons and different shape which is exist in daily life too. The student will be asked to measure the each sides of different figure. And, Area can be defined as the amount of space inside the boundary of a flat object such as square, Rectangle etc as shown below.

1	2	3	4	5	6	7	8	9	10

Area=10cm^2

1	2	3	4
5	6	7	8
9	10	11	12

Area=12cm^2

Individual class work: Find the area of these shapes.

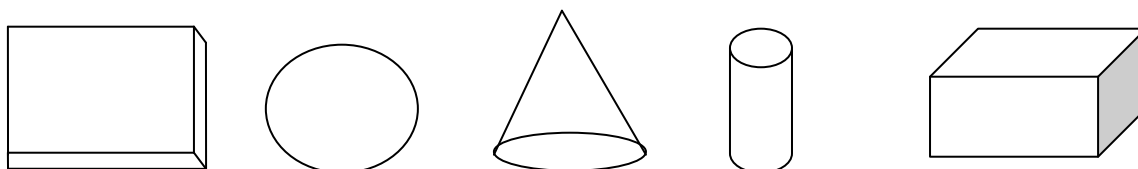Individual class work: Find the area of these shapes.

7cm

3 cm

4 cm
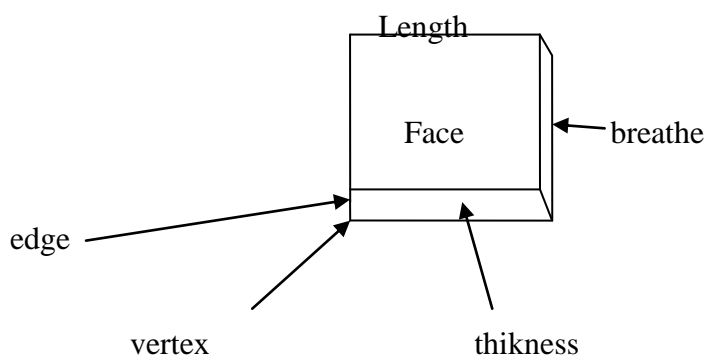

3 cm

Teaching Episode-10

Topic: Volume of solid

Objectives: To enable students to

> ➤ Recognize three dimensional objects .

> ➤ Determine the volume of a solid cube and cuboid.

Performance: The objects shown on the given below will be places in the table and students will be asked to name the objects.

Explaining the students as shown below :

Volume will be defined to the students by filling some shapes like a juice can a cylinder or a lunch box (a cuboids) with water. The amount of water which either shape will hold can be poured into a measuring cylinder to find the volume.

The formula for calculating the volume will be explained.

- volume(v)= length x breadth x height

45

- Volume of cube is (l=b=h) cm^3

Individual class work: Measure the given solids figure and find volume.

Home work: Find the volume of the following shapes using the formulae.

7cm   →4cm

5cm
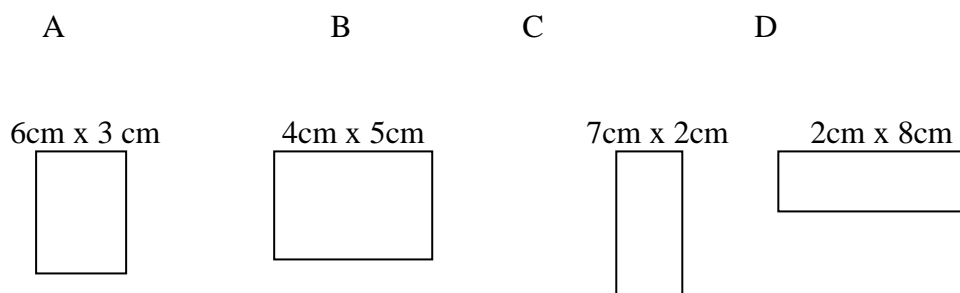

3cm

Teaching Episode-11

Topic: Measurement of Length and Area

Objectives: To enable students to

- ✓ Make rectangles and Sequences using small square tiles.

- ✓ Find the number of unit squares that will cover a square/rectangular region.

Manipulative Materials : Cut-outs or small squares, sheets

performance: Teacher gives a sheet on which 4 rectangles have been printed with A,B,C,D and smaller square cut-outs of +cm by +cm to each group.

A   B   C   D

6cm x 3 cm   4cm x 5cm   7cm x 2cm   2cm x 8cm

Students cover the rectangles with the smaller square cut-outs of + cm by + c, . Then they will find, Total no. of squares = No of squares on the larger side x No. of Square on the shorter side ie. Area=length x breadth.

Class work: Find the number of cut-outs that fill the given region below.

8cm x 4cm

T   e-12

Topic: operation of Fractions:

Objectives: To enable students to

- ✓ Multiplying two fractions using the idea of area of rectangle.
- ✓ Multiplying fraction by fraction.

Manipulative Materials: cut-out shapes.

performance: Teacher gives students square sheets of paper to represent the plot of land.
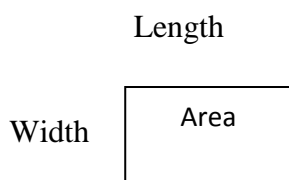
Length

Width | Area

After, that they fold the paper into 3 equal parts vertically and shade a third part of it .

Teacher guides students to fold the sheet again horizontally into halves and shade one half of it in another way. Student identify the region with double shading as Fati's partion of the plot that is $\frac{1}{2}$ of $\frac{1}{3}$. Teacher gives another example as in step first.

Class Work: Find the product of $\frac{1}{2}$ x $\frac{1}{3}$ by using rectangular fig.
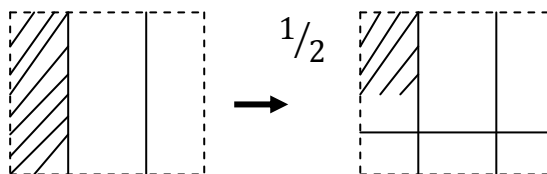
Teaching Episode-13

Topic: Measurement and volume.

Objectives: To enable students to find the volume of solid figures by using cube.

Manipulative Material: Sets of base ten blocks or individual cubes, Two containers (glass, vase etc) that can hold water, small round objects. one container that is a rectangular prism. water and sticky notes.

Performance: Explain that the cubes fit together perfectly we use cubic units to measure the space inside an object, called volume. Distribute a paper cup of small cubes and few sticky notes to each student or pair. Instruct students to make a shape with the cube. Have them write the volume of their shape on the sticky note. The shape can be irregular. Now, have students create another shape with their cubes and write the dimensions of their shape and the volume on a new sticky note (3 x 2 x2=12 units) . They may notice the formula short cut.

Teaching Episode-14

Topic: Lines, line segment and Rays

Objectives: Students will be able to identify and draw parallel, interesting and perpendicular lines.

Manipulative Materials: Two pieces of string or farn cut into three feet length, chart paper with several quadrilaterals with parallel and intersecting lines creating perpendicular corners on it. 3" x 5" index card, colored pencils.

Performance: Ask for students volunteers to come up to the front of the room and demonstrate the three types of lines. Take out the two pieces of three foot long rope. Give each students one end of the rope to hold. Position students so they create parallel lines. Ask students to describe the position of the lines state the lines are called parallel lines. Rein force that parallel lines one lines that run side by side and never touch. Position the student two lines intersect at common point. Discuss how these two lines intersect at common point. Re position the students to create a plus sign with the lines, creating an intersection with go degree. Rein force these lines are called perpendicular lines.

Topic: Measurement of Length and Area

Objectives: To enable students to

  ✓ Make rectangles and Sequences using small square tiles.

  ✓ Find the number of unit squares that will cover a square/rectangular region.

performance: Teacher gives a sheet on which 4 rectangles have been printed with

A,B,C,D and smaller square cut-outs of +cm by +cm to each group.

  A   B   C   D

  6cm x 3 cm   4cm x 5cm   7cm x 2cm   2cm x 8cm

Students cover the rectangles with the smaller square cut-outs of + cm by + c, .

Then they will find, Total no. of squares = No of squares on the larger side x No. of

Square on the shorter side ie. Area=length x breadth.

Class work: Find the number of cut-outs that fill the given region below.

                            8cm x 4cm
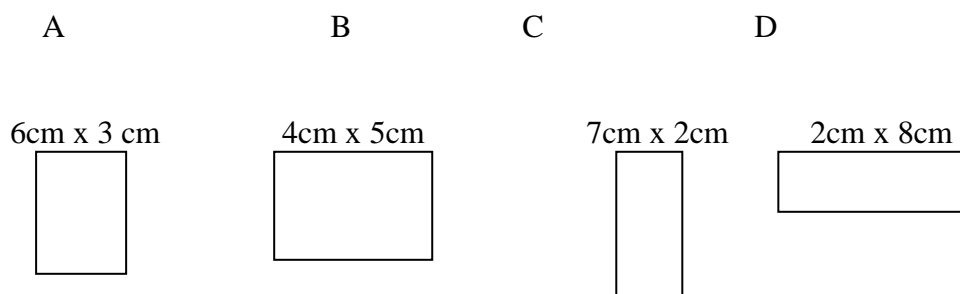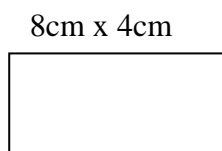
Teaching Episode-16

Topic: operation of Fractions:

Objectives: To enable students to

- ✓ Multiplying two fractions using the idea of area of rectangle.

- ✓ Multiplying fraction by fraction.

performance: Teacher gives students square sheets of paper to represent the plot of land.

Length

Width [Area]

After, that they fold the paper into 3 equal parts vertically and shade a third part of it .

Teacher guides students to fold the sheet again horizontally into halves and shade one half of it in another way. Student identify the region with double shading as Fati's partion of the plot that is $1/2$ of $1/3$. Teacher gives another example as in step first.

Class Work: Find the product of $1/2$ x $1/3$ by using rectangular fig.
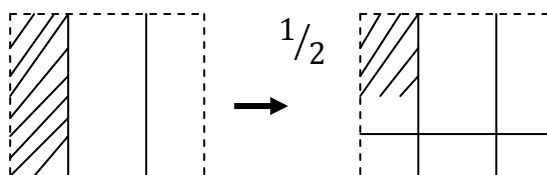
Teaching Episode-17

Topic: Measurement and volume.

Objectives: To enable students to find the volume of solid figures by using cube.

Performance: Explain that the cubes fit together perfectly we use cubic units to measure the space inside an object, called volume. Distribute a paper cup of small cubes and few sticky notes to each student or pair. Instruct students to make a shape with the cube. Have them write the volume of their shape on the sticky note. The shape can be irregular. Now, have students create another shape with their cubes and write the dimensions of their shape and the volume on a new sticky note (3 x 2 x2=12 units) . They may notice the formula short cut.

Teaching Episode-18

Topic: Lines, line segment and Rays

Objectives: Students will be able to identify and draw parallel, interesting and perpendicular lines.

Performance: Ask for students volunteers to come up to the front of the room and demonstrate the three types of lines. Take out the two pieces of three foot long rope. Give each students one end of the rope to hold. Position students so they create parallel lines. Ask students to describe the position of the lines state the lines are called parallel lines. Rein force that parallel lines one lines that run side by side and never touch. Position the student two lines intersect at common point. Discuss how these two lines intersect at common point. Re position the students to create a plus sign with the lines, creating an intersection with go degree. Rein force these lines are called perpendicular lines.

Appendix - A

Statistical formulas and symbols used for data analysis :

1. Mean (x) = $\frac{\sum fx}{N}$ Where N= $\sum f$

2. Variance= $\frac{\sum(\overline{x-x})^2)}{N}$

3. SD= $\frac{\sqrt{\sum f(\overline{x-y})^2}}{N}$

4. T-test formula for an equal variance (t) =

$$\frac{(x_1-x_2) - \mu_1 - \mu_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

Where degree of freedom in equal to n_1-1 or n_2-1

$\overline{x_1}$ = Mean of experimental group

$\overline{x_2}$= Mean of control group

s_1 2 = Variance of E-group

s_2 2 = Variance of C-group

N_1= No. of Students of E-group

N_2 = No=of Student of C- Group.

APPENDIX - B

SPLIT- HALF RELIABILITY CALCULATION FOR TEST

Students	Odd	Even	Sum	Difference
A	22	16	38H	6H
B	22	16	38H	6H
C	18	18	36H	0
D	16	19	35	-3L
E	21	13	34	8H
F	18	16	34	2
G	8	7	15	1
H	9	5	14	4
I	4	10	14	-6L
J	4	8	12L	-4L
K	6	6	12L	0
L	5	6	11L	-1

	Column Sum	Column Difference
Sum of three highest	112	20
Sum of three lowest	35	-13
Difference	$D_S = 77$	$D_d = 33$
Difference of squared	$D_s{}^2 = 5929$	$D_d{}^2 = 1089$

Therefore, Reliability (r_{tt}) = 1- $\frac{Dd\,2}{Ds\,2}$

$$= 1- \frac{1089}{5929}$$

$$= 1-0.1837$$

$$=0.81$$

Appendix E-1

Pretest scores of experimental and control group

S.N	obtained mark (x)	$x_1=(x-x_1)$	x_1^2	S.N	obtained mark	$x_2=(x-x_2)$	x_2^2	x_1x_2
1.	19	3.4	11.56	1	21	5.2	27.04	17.68
2.	19	3.4	11.56	2	21	5.2	27.04	17.68
3.	18	2.4	5.76	3	19	3.2	10.24	7.67
4.	18	2.4	5.76	4	19	3.2	10.24	7.67
5.	17	1.4	1.96	5	19	3.2	10.24	4.48
6.	17	1.4	1.90	6	17	1.2	1.44	1.68
7.	16	0.4	0.16	7	17	1.2	1.44	0.48
8.	16	0.4	0.16	8	15	-0.8	0.64	0.32
9.	15	-0.6	0.36	9	15	-0.8	0.64	0.48
10.	15	-0.6	0.16	10	13	-2.8	7.84	1.68
11.	14	-1.6	2.56	11	13	-2.8	7.84	4.48
12.	13	-2.6	6.76	12	12	-3.8	14.44	9.88
13.	13	-2.6	6.76	13	12	-3.8	14.44	9.88
14.	12	-3.6	12.96	14	12	-3.8	14.44	13.68
15.	12	-3.6	12.96	15	12	-3.8	14.44	13.68
Total	234		81.54				162.4	110.78

Where,

$N_1 = 15$ $N_2 = 15$

Mean $x_1 = 15.6$ Mean $(X_2) = 15.8$

variance$(s_1^2) = 5.43$ variance $(S_2^2) = 10.82$

SD $(s_1) = 2.33$ SD $(S_2) = 3.28$

Appendix E-2

Post test scores of experimental and control groups

S.N	obtained mark	$x_1=(x-x_1)$	x_1^2	S.N	obtained mark	$x_2=(x-x_2)$	x_2^2	x_1x_2
1.	36	1.47	2.16	1	30	3.54	12.53	56.20
2.	40	6.47	41.86	2	27	0.54	0.29	2.91
3.	34	0.47	0.22	3	25	-1.46	2.13	-6.68
4.	33	0.53	0.28	4	20	-4.6	41.73	-3.42
5.	30	-3.53	12.467	5	26	-0.46	0.21	1.62
6.	41	7.46	55.80	6	31	4.54	20.61	33.86
7.	38	4.47	19.98	7	34	7.54	56.85	33.70
8.	36	2.47	5.10	8	27	0.54	0.29	1.33
9.	27	-6.53	42.64	9	26	-0.46	0.21	3.003
10.	28	-5.53	30.58	10	26	-0.46	0.21	2.54
11.	31	-2.53	6.40	11	25	-1.46	2.13	3.69
12.	36	2.47	5.10	12	24	-2.46	6.05	-5.07
13.	33	0.53	0.28	13	24	-2.46	6.05	-1.30
14.	35	1.47	2.16	14	27	0.54	0.29	0.79
15.	26	-7.53	56.70	15	25	-1.46	2.13	10.99
Total	503		281.72		397		151.71	88.16

Where,

$N_1=15$ $N_2=15$

 Mean $(X_1) = 33.53$ Mean $(X_2) = 26.46$

 variance $(S_1^2) = 19.91$ Variance $(S_1^2) = 10.11$

 SD $(s_1) = 4.34$ SD $(S_2) = 3.17$