Chapter I

INTRODUCTION

Background of the Study

The word "mathematics is derived from an ancient Greek word 'Mathancian' which meant, "to learn". So mathematics is a process of learning and it is an expression of human mind, concerned chiefly with ideas, processes and reasoning. Its basic elements are logic and intuition, analysis and construction; generality and individuality. It is a way of thinking, a way of organizing a logical proof. As a way of reasoning, it gives us insight into the power of the human mind and becomes a challenge to intellectual curiosity. It is a language in which we use diagram and symbols, instead of words. Darwin (1809-1882) quoted that "Every new body of discovery is in mathematical form, because there is no other guidance we can have" So, mathematics is an organized structure of knowledge in which each proposition is deduced logically from previously proved propositions or assumptions and it comprises skill, techniques and arts by which man conveys ideas, concepts and fact. According to Sylvester (2010);

> Mathematics is not a book confined within a cover and bound between brazen claps whose contents it needs only patience to ransack; it is not a mine, whose treasures may take long to reduce into possession, but which fill only a limited number of veins and lodes: it is not a soil whose fertility can be exhausted by the yield of successive harvests; it is not a continent or an ocean, whose area can be mapped out and its colour defined: it is limitless as that space which it finds too narrow for its aspirations; its possibilities are as infinite as the worlds which are forever crowding in and multiplying upon the astronomer's gaze; it

is as incapable of being restricted within assigned boundaries or being restricted within assigned boundaries or being reduced to definitions of permanent validity, as the consciousness of life, which seems to slumber in each monad, in every atom of matter in each leaf and bud cell, and is forever ready to burst forth into new forms of vegetable and animal existence.

Mathematics has grown with the development of humankind from its earlier civilization up to the present modern civilization. No one can deny the importance of mathematics because of its wide utility from day to day activities to space technology. The liberal arts in the early Greek were studied basically focusing for the aesthetic values. Society changed in its economic activities, life pattern, and cultural value system. But the needs and demands of the society also changed. According to William & Sheaf (1985);

Mathematics is the science that treats of quantity or magnitude, and of other measurements, especially by the use of symbols, and that investigates deductively the spatial, serial and numerical relations existing between objects of perception; in a wider sense, the group of allied sciences concerned with the concrete application of such abstract data (p. 1527).

The aim of education is to prepare citizen for the changing reality according to the needs and demand of the existing society and the immediate future society. Consequently, mathematics education in the 20th century is no more limited to aesthetic values only. It puts great emphasis in today's mathematics programme to meet the needs and demands of rapidly growing society due to changes in science and technology. Howson (1973) writes as;

Mathematics is the science that yields the best opportunity to observe the working of the mind [and] has the advantage that by cultivating it we may acquire the habit of a method of reasoning which can be applied afterwards to the study of any subject and can guide us in the pursuit of life's objects (78).

Indeed, the study of mathematics occupies a central place in the school programmes of all countries. It has been estimated that in most school systems, 20 percent of the total instruction time is devoted to mathematics. Only mother tongue, reading and literature are allotted as much time as mathematics. (Husen and Postteth Waite, 1985, P. 32-58).

Mathematical knowledge is essential to human life for superior living in present scientific and technology period. Mathematical skills should provide to support every society for development. As a whole, mathematics increases logical thinking, understanding capacity and efficiency in human being. Therefore, mathematical skill is one of the most important and essential parts of human life. With mathematics people experience easy to live in this world. In this context, Sidhu (1982) mentioned clearly about the importance of mathematics as follows:

Now-a- days one can't do anything without use of fundamental process mathematics in the daily life. A common man can get on sometimes very well without learning, how to count and calculate. The knowledge of mathematics is fundamental process and the skill to use them are the preliminary requirement of a human being these days.

Mathematics is an important subject, which is inseparable discipline of human life because of its usefulness for each and every human activity. Mathematics has direct impact for the development of physical and social science. It is the base of

3

scientific development of modern technology. It is also very useful tool in commercial and industrial fields as well. All the scientific discoveries depend upon mathematics because it is the backbone of studying science and it supports the concentration of related study. Mathematics provides different techniques in studying very useful information of figures charts, diagrams, graphs, geometrical figures, technical drawing and so on.

Principles that are learned and applied in classrooms problem-solving sessions are more likely to be transferred to the other problem-solving situations than principles that have not been applied in solving-problems. Mathematics problem solving can help students to improve their analytic powers and can aid them in applying these powers in diverse situations. Solving problem can also help students to learn mathematical facts, skills, concepts and principles by illustrating the application of mathematical objects and the interrelations among object. (Pandit, 2007).

Since problem-solving in mathematics is a fascinating activity for most students that can improve motivation which makes mathematics more interesting for many students. However, problem solving can also decrease motivation if speed, precision, format neatness, and finding the correct answer. Problem solving is difficult and it can be very frustrating for students if their teachers do not exhibit patience and understanding and offer unobtrusive assistance. In teachers approach of problem solving by providing a relaxed supportive classroom environment, student can have the satisfaction of finding creative and original solutions to mathematics problems.

The importance of problem solving in mathematics and the fascination that mathematics problem-solving holds for many people have been illustrated throughout the history of mathematics and mathematics education. The problem of trisecting an angle led to important mathematical discoveries in the theory of equations. Attempts

4

at square the circle led to the discovery of transcendental numbers. Numerous attempts to prove Euclid's parallel postulate of plane geometry influence the development of important new geometries. The fascination of problem-solving in mathematics is also illustrated in national and international mathematical problem-solving contents. (Bell, 1978).

Polya (1945) defines problem solving as "to find a way when no way is known off- hand, to find a way out of difficulty, to find a way among an obstacle, to attain a desired end that is not immediately attainable by appropriate means. There is no problem unless the individual has the desire to find a solution." (NCTM, 1980, P1)

The national council of teacher of mathematics (NCTM, 1980) recommended that problem- solving be the focus of mathematics teaching because they say it encompasses skills and functions which are important part of everyday life. Furthermore, it can help people to adapt and change the unexpected problems in their careers and other aspects of their lives.

Teaching Mathematics in Nepal

Mathematics is an inseparable subject from human life. The history of modern education is not much longer as it is in the western countries. Establishment of Durbar High School (Oct. 1853) for educating Rana families, then the rule, opened the door of today's formal education in Nepal. This formal education needed course of study/curriculum to run the classes regularly. Both the teachers and the students needed textbooks and other curricular materials to teach and learn mathematics. There was no curriculum and text book written for the Nepalese context. So Durbar High School then had used Indian courses of study and Indian textbooks. This tradition of using Indian text books continued when Durbar High School had been opened to all public and in other schools in different parts of the country for there were no

alternatives excepts Indian publication. Teacher came from India and aboard (Britain, America) to teach mathematics. Mathematics was not systematic in school subjects before the advent of democracy in 1951. After the advent of democracy in 1951, the democratic government realized the importance of education, to start to re-organize the schools education, to revise the syllabus.

In 1952, Education Board was established to supervise and extend the existing education faculties. In 1953, the education board suggested the government to appoint National Commission for Planning Education and the board also established the National Teacher Center in 1953.

In 1967, the college of education under the sponsorship of Nepal Government launched at a school mathematics project named Program for Revision and improvement in mathematics (PRIME). The purpose of this program was to make mathematics program effective and meaningful.

From 1971 to 1976, the National Education System Plan brought a very significant change in mathematics education in Nepal. It attempted to bring out systematically organized and pedagogically sound curriculum of schools education. The national education plan state the importance of Mathematics curriculums as: "Mathematics like language is a basic tool of communication. Daily transaction and communication involves the frequent use of mathematical concepts. Thus, it is quite natural that mathematics be given very important place, second to language, in school education".

According to NESP, the objectives for primary level (1-3) were to make the students literate on mathematics and to provide basis for lowery secondary level mathematics (4-7). The objective of mathematics for lower secondary level was to make the students able to solve the mathematical problems, which appear in daily life,

and to overcome different mathematics facts, rules, and formulae for secondary level (8-10). Students should be able to perceive accuracy and they should be facilitated in mathematics computation in solving verbal problems were the objective of secondary school programs.

Similarly, curriculum implementation plan (1981) improved the curriculum of 1971 and textbooks. National educational commission (NEC) of 1992 has given some suggestions to improve the standard of education.

According to the suggestions given by NEC (1992 A.D.), CDC has brought improvements in school curriculum and textbooks. In this context, school level mathematics curriculum has been revised and textbook of different grades have been written and implemented. Necessary modifications have been made in our secondary school mathematics curriculum by omitting some old concepts and contents and introducing new concepts and new topics. Thus mathematics curriculum 1992/93 A.D. had given continuation of reform in the mathematics curriculum and included more concepts of modern mathematics, useful for latest development of other social sciences to cope with the introduction of scientific approaches. It has introduced many new terms, symbols, concepts and approaches and demanded new mathematics teachers or well trained teachers.

The present school level curriculum has been divided into three parts-primary mathematics curriculum (1993), lower secondary level (1994), and secondary level curriculum (1997).

In Nepal, significant changes in the field of education have taken place with introduction of multiparty democracy in 1990 A.D. The National Education Commission 1992 recommended that the school curriculum be revised in the contest of recent political change and needs of the society to meet the demands of the modem

days. Accordingly, several attempts have been made for the development of curriculum in effective ways; especially focus was given on the development of mathematics. Considering this view, several searches have been done to find out of weakness behind the poor achievement in mathematics.

The National Education System Plan (NESP 1971-76) as well as other education commissions has realized that a well-grounded understanding in mathematics is essential in every life as well as for higher studies in the field of science and technology. So the NESP stated about the need and important of mathematics in school curriculum as:

"A well ground understanding of mathematics is essential for everyday life as well as for higher studies in the field of science and technology. Mathematics like language is a basic of communication. Daily transactions and communications involve the frequent use of mathematical concept."

Since NESP consider compulsory mathematics as an essential component of secondary school education. With the reestablishment of democracy in Nepal in 1990 A.D. Curriculum Development Center (CDC) has brought some improvements in school curriculum and textbooks. Accordingly, the improved textbooks of different grades are being implemented from 1992 A.D. observing the result of school leaving Certificate (SLC) examinations of the last three years, no more than 46% of the students have been passed as a whole and nearly 60% students have been failed in mathematics. This failure percent is high in comparison to other subjects. In such situation, it is common that students, parents, teachers along with others are worrying about it. Only one reason may not responsible behind the high rate of failure in mathematics. Curriculum, textbooks, teachers training and its preparation teaching materials and its use, teaching method, language, socio cultural and economical status

may be the other responsible factors behind high failure rate in mathematics. Several studies have shown that the achievement in mathematics is affected by variables of languages, ethnicity, gender, socio economic condition of the students' families. (K.C. 2001).

Statement of the Problem

The study was concerned with the problem solving method and its importance for teaching learning secondary level mathematics. Especially this study has been focused on the answer of the following question:

- Does the problem solving approach of teaching affect the achievement of students in mathematics in Arithmetic with compare to traditional method of teaching at grade IX?

Significance of the Study

Mathematics as well as mathematics education plays a very important role in development. Mathematics is a compulsory subject in school curriculum. The most importance of the problem solving method in teaching mathematics is that, the students can understand and solve the problem easier than using other methods. This method develops thinking and analytical power of the students. The following were the major significance of the study.

- The study helps to the curriculum designer, specialist and other.
- The study helps new teacher as well as partial trained teacher.

Objectives of the Study

The objectives of the study were :

- To compare the achievement of the students taught by problem solving method and traditional teaching method.

- To find the effectiveness of problem solving method in teaching mathematics.

Delimitation of the Study

The study was limited to two schools of Kathmandu District.

- Only the government school was included in this study.

- The experimental duration of this study was done for four weeks

- The study was based on "effectiveness" of teaching mathematics using problem solving method as stated by Polya.

Hypothesis of the Study

The statistical hypothesis formulated in this study is presented below.

$H_o: \mu_1 = \mu_2$

$H_1: \mu_1 \neq \mu_2$

Where, $\mu_1 \ and \ \mu_2$ are the mean achievement of score of experimental and control group students respectively.

Operational Definition of Related Terms

The researcher defines the related terms much more precise and unambiguous way, however, definition must be based on theory that is generally recognize as valid. Researcher defines the following related terms:

Problem Solving Method

The method which is based on the possible problems and their solution in the classroom instruction. It is student centered method, since the students gain knowledge by step to step. Both teachers and students are good participants in this

method because without understanding it, we can't go to next step. It is sequential programmed in classroom instruction. It is also recognized as an example of a scientific approach of learning, which mentions the rational competition of the students in a group or individual.

Traditional Method

The method which is based and followed from the tradition and history of mathematics teaching is known as traditional method. In this method, the teacher is one of the authority of teaching learning activity and the students passively accept the fact exposed by the teacher.

Achievement

The achievement in this study is defined in terms of scores obtained by the students in mathematics tests constructed by the researcher.

Control Group

The group which was taught by the researcher using traditional method of the teaching is defined by "Control Group" in this research.

Experimental Group

The group that was taught by the researcher by using problem solving method of teaching is called Experimental Group in this research.

Effectiveness

The effectiveness of this study is defined in the terms of the magnitude of the score obtained by experimental and control groups in the mathematics achievement test. The statistically significant mean score obtained by the students of both experimental and control groups indicates the effectiveness in this study.

Comparison in the difference between two teaching methods with their student activities participation, daily homework, student discipline and also student attendance in school are analyzed and finding better one.

Study Variables

Study variables are the conditions or characteristics that the experiment manipulates, controls or observes in this study.

Chapter II

REVIEW OF RELATED LITERATURE

A review of literature is the process of locating, obtaining, 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.

Review of literature is an essential part of all types of studies. It is the way to discover what other research in the area of our problem has untouched. A critical review of the literature helps the researcher to develop, understand and insight into previous research work that relates the present study. Literature review is basically a 'stock taking' of available literature in ones field of research. The literature survey provides the students with the knowledge of the status of their field of research. The library is rich storage base for all kinds of published materials, thesiss, business reports and government publication. The primary purpose of literature is to learn not to accumulate. It enables the researcher to know:

- What research has been done in the subject?
- What others have written about the topic?
- What the approach taken by other researcher?
- What theories have been advanced?
- What are the agreements and disagreements?
- Whether the gaps can be filled through the purposed research?

Empirical Literature

Many studies have been conducted about teaching methods, teaching problems, faced by the teachers, instructional materials, students 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 of problem solving method in learning mathematics at 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 illustrated as follows:

Quaiyum (2003) did the research work on "A study of students problem solving methods in mathematics at secondary level of Nepal" with the aim to determine the difference between boys and girls of secondary school. He applied problem solving approach and to assess the difference between boys and girls of secondary school with regard to attitude towards mathematical problem solving. Multi stage stratified random sampling has been used in the selection of districts, schools and students from central development region of Nepal. The sample consists of 250 boys and 182 girls of grade IX from five districts. The t-test was applied and concluded that there was significance between boys and girls regarding applying problem solving approach to mathematics and found with regard to attitude towards mathematical problem solving. He concluded that boys seemed to be more capable in comparison to girls.

Kandel (2007) did a research on "Effectiveness of problem solving approach in arithmetic at lower secondary level" with the aim to explore the effectiveness of problem solving approach in addressing genders in learning arithmetic at grade VII. In 130 students, 25 students were selected for experiment and 25 were selected for control group. Statistical tools were mean and standard deviation and t-test was used

to compare the achievement at 0.05 level of significant. He concluded that problem solving approach of teaching was better than the traditional approach of teaching.

Yadav (2008) did a research on "Effectiveness of problem solving method in teaching algebra at lower secondary level" with the aim of prior use of experiment verification by teaching algebra with problem solving method. Among 56 students 42 were randomly selected with 21 students for experimental and 21 for control group. The data obtained from final achievement test was analyzed and interpreted by using t-test at 0.05 level of significance and concluded that the experimental verifications have significant effect on teaching algebra.

Parajuli (2009) did an experimental research on "A study on the effectiveness of teaching mathematics by using problem solving method at lower secondary level mathematics" with the aim of prier use of experimental verification by teaching arithmetic with problem solving method. Among 60 students, 30 students were selected randomly with 15 students for experiment and 15 for control group. The data obtained from final achievement test was analyzed and interpreted by using t-test at 0.05 level of significance and concluded that the experimental verification have significant effect on teaching mathematics.

Subedi (2010) did his research on "A study on effectiveness of problem solving method in teaching mathematics at secondary level" He chose the pre test, post test, equivalent group design to conduct this study. 26 students of Shree Purna Higher Secondary School were selected as experimental group and 24 students of Saraswati Higher Secondary School were selected as control group on fire coin toss. Achievement test and teaching modules were the main tools for the study.Mean, standard deviation, variance and t-test at 0.05 level significance were used as statistical tools for the study. After the obtained data, it was concluded that boys and

girls were similar in learning mathematics and problem solving method of teaching has better achievement then that of the traditional method of teaching.

Dewan (2011) did an experimental research on "Effectiveness of problem solving method in teaching arithmetic at grade VI" with the aim to compare the achievement levels of students taught by experimental problem-solving approach to the achievement of students taught by traditional approach. A post test equivalent group design was adopted to conduct the experiment in grade VI. The researcher selected carried out this experiment in two schools of Dhankuta district. Among the population of the study, 46 students were randomly selected with 21 for experimental and 25 for control group. Mean, standard deviation and t-test were used to compare the achievement level of students. She concluded that problem-solving approach of teaching mathematics was better than the usual traditional approach of teaching mathematics.

Paudel (2014) conducted an experimental research on "Effectiveness of problem solving methods in teaching mathematics in Syangja district" with the aim of the experimental verification by teaching arithmetic with problem solving method at lower secondary level. He took40 students from two schools, 21 students were selected for experiment and 19 for control group. The criteria for the selection was marks obtained in pre-test between 20-33 marks. The data obtained from final achievement test was analyzed and interpreted by using t-test at 0.05 level of significance and concluded that the experimental verification have significant effect on teaching mathematics.

The major question is that, can problem solving method in teaching mathematics be more effective than the traditional method? Similarly, what sort of effect can be found in gender variation when problem solving method is

implemented? And what are the reasons to prove that problem solving method in teaching mathematics is more fruitful over traditional method are the questions and this study had been held to find out reliable answers. On the other hand, preparing teaching module (or lesson plan) according to the theory of problem solving approach is one of the challenging task. Thus for the validity of the modules, the researcher used the theory according to the method after studying its major aspects deeply.

Most of the above review of related literature shows no investigation has been concerned on effect of problem solving approach in developing the ability to solve a wide variety of complex problems in secondary school students. The effectiveness of problem solving has been an important area of study in teaching and learning mathematics. Our concern of the study is effectiveness of problem solving on learning mathematics, based on the theory of Polya and Bell. Several attempts have been made by different researchers and mathematicians. Many scholars have conducted their research in this area.However, no attempt has been made to study about problem solving in learning mathematics. So, I think my research will be new in mathematics learning. And my study will cover each and every aspects of problem solving method in teaching mathematics.

Theoretical Literature

Problem solving is a method of teaching to accomplish the instructional goals for various problems of learning facts, concepts and procedures as well goals for problem solving within the problem context. Polya (1945) writes problem solving method as to endeavor to understand and the process of solving problem, especially the mental operation typically useful in this process. He believes that the students should acquire as much experience of independent work as possible. The students learn nothing if they are kept passive with teacher's much efforts. The teacher should

think the level of the students and ask as much key questions or make useful suggestions as possible. The questions and suggestions offered to the students should be based on general principles and practicality of the students' common sense that the students could have thought of themselves. The teacher just try to indicate general directions according to the level of students.

Problem solving strategies are method that can be used successfully to solve the problems of various type. It can help students to develop and extend a repertoire of strategies and method that they can apply when solving various kind of problem like instructional problem, routing problems and non-routing problems. Problem solving strategies include making a model, picture or diagram, looking for pattern, guessing and checking, making assumption etc. It is also taken for research in psychology. In mathematics, problem solving method is used for various reasons that it allows students to develop mathematics understanding and gives meaning to skill and concepts in all stands, it increases opportunities for the use of critical thinking skills, it initiates students communicate ideas, make connections and apply appropriate knowledge and skills in the obstruct institution. Problem solving helps students to find interesting flavor in mathematics.

General questions such as "What are the known?" and "Have you ever solved a problem with similar cases?" are applicable in many cases. With these questions, the students may learn to ask themselves such questions in turn for similar such cases. The teacher should put these questions and suggestions to the students as much as possible. Through the use of imitation and practice the students will eventually discover the right use of these questions and suggestions as per the demand. Polya collected various questions and suggestions that were useful in problem solving and grouped them under different headings of problem solving. For problem solving Polya

suggested so many methods to solve the problem. But Polya problem solving method is the way to describe as understanding the problem, making a plan, carrying out the plan and looking back. Polya's four steps of mathematical problem solving method are as follows:

- Understanding the problems

- Making a plan

- Carrying out the plan

- Looking back

Understanding the Problem

The mathematical facts should follow the normal procedures of problem solving methods. First, the students should identify the given problem instead of asking questions; the teacher should explain, i.e. Do you understand the problem? The teacher should command the students to relate the problem. The objectives of this step are given below:

- To find out the problem and which things are needed to fix and be confirmed.

- To find out which problem has given.

- To find out necessity, symbol and formula.

- To make the framework of problem and to find out right and wrong statement.

- To bring out the given problem and divided it.

The above mentioned points state that the students should understand the verbal statement of the problem. The teacher can check this to some extent by asking them to repeat the statement and find out the principal parts of the problem. The teacher can assist them with the solution of the unknown problem.

Making a Plan

After understanding the problem clearly, the teacher should think about the plan. The focus should be given to problem solving contexts and inquiry-oriented environment to assist the students construct a deep level of understanding mathematical ideas and processes by involving themselves. The strategies used to engage the students in the step of making a plan are: creating, conjecturing, exploring, testing and verifying. While making plan to enhance the students' skill, the following points should be taken into consideration.

- Like this problem the students solved or not to think out and analyzed.

- To think out common comparison and different quantity.

- To concern about the given problems and find out it's structure.

- The important words are used carefully; for example: If the student had seen addition; they would give the instruction of addition or subtraction and encourage the students to solve it.

- Given problem can be easily divided.

- To find out the difficult problem by the help of easier one.

According to this step, the teacher mentions that there are many reasonable ways to solve the mathematical problems. However, it is judicial to choose suitable techniques to solve the given problem. The skill at choosing an appropriate strategy is best learned by problem solving method. A list of strategy such as guess and check, look for a pattern, make an orderly list, draw a picture, solve a simpler problem, consider special cases and use formula, etc. the students to make a suitable plan for solving mathematical problems.

Carrying out the Plan

After the identification of the problem and a suitable plan to solve the problem, the students should make an outline to solve the problem. The teacher should encourage the students to make them active and provide guidelines. The students should know how to carry out the plan. For this, we plan the problem solving, we have to implement according to our plan. The following points should be considered while carrying out the plan.

- According to our plan we have to solve the problem by using paper and pencil for each and every stage.
- To find out the findings by the help of appropriate stage of plan.
- To give the logical answer for the findings.
- The question should be asked according to the student level.

From the above points, it is clear that the students find out the solution for a given problem. The teacher only guides them to make an appropriate outline. The teacher should ask related questions to guide them while finding out a solution.

Looking Back

After finding of the solution to the problems it should be examined whether is it true or not? In many cases there may be alternative methods of solution perhaps shorter and easier ones than the existing method. The teacher should ask the students whether the problem can be solved in various techniques, one easy and simple technique that is the best should be taken in this stage (Pandit, 2007).

Polya's problem solving method is like swimming in the pool or playing the piano. It seems hard, terrifying and unpleasant in the beginning but the practice makes it more interesting, automatic and enjoyable. It helps to recognize a problem, interpret, define and delimit the problem. The students can gather data in a systematic

21

way. They can organize and evaluate the data. They can also formulate a tentative

solution to a correct solution. Finally, they can verify the result. Thus, mathematics as

the subject of problems, it is effective to implement Polya's problem solving method

in teaching and learning mathematics.

Chapter III

METHOD AND PROCEDURES

The present study is based on the line of experimental research design. A description of the procedures used in sampling, instrumentation, data collection and analysis are discussed in the following pages:

Design of the Study

The research plans which were developed before starting the research work was an experimental research design. In this research design the pre-test, post-test non-equivalent group design were adopted by the researcher. The design of the study was as follows:

Group	Pre-test	Treatment	Post- test
Experimental Group	T_1	Problem Solving Method	T_2
Control Group	T_3	Traditional Method	T_4

This study was an experimental type having two groups, experimental group and control. The experimental group was taught by using problem solving method and the control group was taught by traditional methods of teaching mathematics. Since they were not comparable in pre-test scores, the post test scores were taken by using t-test. The researcher compared the scores for the difference between the two average mean differences.

Population of the Study

The population of this study consisted of all ninth grade students of government schools of Kathmandu district. The researcher selected grade 9 students since it is the beginning as well as the foundation level of secondary education.

Sample of the Study

This study was an experimental study which was carried in two schools: Shree Gram Shikshya Mandir Higher Secondary and Shree Baluddhar Higher Secondary School Kapan, Kathmandu. These two schools were selected purposively by the researcher because of expectation of help and co-operation need from the schools. For the students first of all pre-achievement test was conducted to the 23 students (12 students from Gram Shikshya Mandir Higher Secondary and 11 students from Shree Baluddhar Higher Secondary School) of Grade IX of both schools.

Tools

To measure the effect of problem solving method in teaching mathematics, the researcher developed an achievement test for both pre test and post test. The achievement test papers were developed on the basis of mathematics textbook of grade IX, prescribed by the government of Nepal. In both the experimental and control schools similar topics were taught from the same textbook prescribed by the government of Nepal and teaching material were prepared by the researcher to teach both the experimental and control groups. At the end of the experiment, same achievement test with some change was given to the both groups as post test. The test included different contents to measure three level of cognitive domain. They are as follows:

a) Knowledge   b) Comprehensive   c) Application

The mathematics achievement test also consisted of subjective (very short, short and long) type of questions. These were the main tools used in collecting data for the study. The test was prepared on the basis of the prescribed curriculum and text–book of Grade-IX in arithmetic. In knowledge level questions, students had

24

remembered and recalled the terms, symbols, formulae, definition, facts and principles. In understanding level question, students developed understanding of the terms, symbols, concepts and facts. In skill level questions, the students had to apply knowledge and understanding of mathematics to unfamiliar situation and in this type of questions student need to find pre requisite terms and values. In problem solving level question, they had to apply their knowledge, understanding and skill which occurred in new situation. Almost all problem solving questions need to find pre requisite terms and value.

Participant Observation

Observation is a kind of tools that helps to seek knowledge through the use of sense i.e, eyes, ears, nose, tongue and skin. It has great importance not only in research work but also in our daily lives. K.C (2000) writes that direct observation has the advantages of putting researchers into first hand contact with reality. Participant observation is a close and full involvement of researcher in a natural setting in order to experience and understand the behavior interaction event and so on. It helps to bridge and share the intimacy between the researcher and the setting which is under study, by immersing researcher her/himself into the subject being studied. Since the Nepalese classroom constituted by different socio-cultural forces because students from different background have their own lived reality and in the classroom they not simply conform norms and values of the school but also produce difference and these multiple realities influence the life in the classroom as well. To get required information the researcher observed school overall as well as key respondents individually and collectively during their work at school. Classroom, playing with peers, interacting with teachers about 28 days.

Researcher daily note

Researcher was note remarkable events found in the class of both groups. In experimental time student's motivation in learning, regularity in classroom, daily homework, participation in learning and students discipline in learning activities are noted on researcher daily note.

Validation of the tools

Since a tools are valid for a particular purpose and particular group. Therefore, the mathematics achievement test and teaching modules was developed for measuring the problem solving performance as well as achievement of grade IX students. For the estimation of the validity of this test the tools were developed with the help of mathematics teachers, supervisor and other educator and also consulted to measure. The teaching modules were constructed on the basis of four steps of problem solving teaching method according to G. Polya. The suggestions from experts and necessary changes be said that the tools were quite valid.

Reliability of the achievement was determined through an application of split half reliability calculation. The reliability of the teaching modules was tested on student's achievements. Those students who were taught by using problem solving method could follow and apply four steps of problem solving to solve the mathematics problem. So that teaching modules were quit valid.

Scoring the Data

Since the achievement test was questions of different levels and types. Each of types of questions varied according to difficulty level. Knowledge level question demand simple information carry 1 marks as score, the comprehensive level question demand the both information and carry 2 marks each where as the application type of

questions were higher level which demand knowledge as well as comprehensive level of 4 marks each.

Control of variable (Extraneous / Confounding)

Since the experiment was conducted in two different methods. The researcher taught by problem solving method and traditional method herself. The following exercises have been taken to control the variable's.

Teacher Variable

The researcher herself taught both the experimental and control groups. So, the extraneous variables like personality, emotion and qualification of the teacher were controlled.

Intervention Instrument

The control of the lesson plan were based on compulsory mathematics curriculum of grade. Ix so the researcher made lesson plans for experimental group and control group. The equal number of days was teaching Arithmetic for both the groups.

Tools for data collection of the study

The achievement tests were the main tools for collecting the data to find out the mean achievement of control group and experimental group. The same test items were applied on pre-test for both the groups. The time allocated for completing the test was one hour and 30 minutes. The test items for pre-test are presented in Appendix-I

For post- test the test items were different from that of the pre-test but same test items were used for both groups. The test items for post test are presented in Appendix –J

Contents

In both the experimental and control groups same contents were taught from the text books of grade IX which are prescribed by the CDC, Government of Nepal.

Data Collection Procedures

In this study, at first the researcher selected two schools and the student of grade IX. The students were divided into two groups as experimental and control groups. After that both the experimental and control groups were taught by the researcher, the experimental group was taught by using problem solving method whereas the control group was taught by traditional method.

Data Analysis Procedure

The data collected were analyzed and interpreted by using different statistical devices such as mean, standard deviation, variance and t-test. Mean and standard deviation were calculated to obtain the scores in the achievement test. Pooled variance had been taken out to find t-test value. The t-test was used at 0.05 level of significance to find whether or not the significant difference existed between the means of experimental and control groups.

Non-cognitive behavior were analyzed on the text prepared based on the observation of motivation, participant observation, regularity and research daily note, and discussion with teacher and related students as themes emerged in qualitative information. Some narratives observed phenomena are substantiated to the quantitative information and the findings are associated to the previous researches and theories drawing theories drawing theoretical stands.

Chapter- IV

ANALYSIS AND INTERPRETATION OF DATA

The most important part of the study is to analyze the collected data. The data were collected after an experiment in the form of pre-test, post-test, non-equivalent control group design. The present study entitled "Effectiveness of Problem Solving Method in Learning Arithmetic at Grade IX" was primarily an experimental research. The main aims of this study was to compare the achievement score of the students taught by problem solving method and traditional method of learning in grade IX. This study is also intended to explore the effectiveness of problem solving method in learning arithmetic at grade IX.

This chapter deals with the results of statistical analysis and interpretation of data from the achievement score of the sample students. These data were tabulated and analyzed by using different statistical tools such as mean, median, standard deviation, variance as well as t-test. Since the groups were not comparable in pre-test, the post-test scores were taken for the difference between the two average mean differences. The analysis of the study is carried out under following major headings corresponding to the objectives of the study:

- Comparison of Mathematics Achievement of Experimental and Control Group Students in Pre-Test

- Comparison of Mathematics Achievement of Boys between Experimental and Control Group in Post-test

- Comparison of Mathematic Achievement of Girls between Control and Experimental Groups.

- Mathematic Achievement Score between Control and Experimental Group in Post-test Result

Comparison of Mathematics Achievement of Experimental and Control Group Students in Pre-Test

The pre-test score of students of control and experimental group students involves in the calculation of mean and variance. The mean, variance and calculated t-value between two groups on the pre-test result is presented in the following table:

Table 4.1

Comparison of Mathematics Achievement Score between Control and Experimental Group in Pre-test Result

Group	N	Mean	S.D.	Variance	t-value
Control	11	21.18	3.16	9.98	1.28
Experimental	12	23.58	4.49	20.07	

The above table 4.1 presents the mean, standard deviation, and the variance of both control and experimental groups in pre-test result. The table shows that the mean and standard deviation of both groups were nearly same. The mean score of control group was 21.18 whereas the mean score of experimental group was 23.58 The standard deviation of control group was 3.16 and that of the experimental group was 4.49. The calculated t-value is 1.28. Which is less then the tabulated value 2.080 here the null hypothesis is rejected and concluded that there is no significant difference between the achievement of experimental and control group in pre test. So these two groups were treated as similar group.

Comparison of Mathematics Achievement of Boys between Experimental and Control Group in Post-test

The achievement score of control and experimental groups of boys were compared to find out effectiveness of problem solving method. The results of mean, variance and t-value are given in the following table:

Table 4.2

Comparison of Achievement Score between Control and Experimental Group in Post-test Result

Group	N	Mean	S.D.	Variance	t-value
Control (boys)	5	26	3.4	11.56	
Experimental (boys)	5	33.2	1.72	2.96	4.225

It is to be noted that the boys from experimental and control groups obtained mean score as 33.2 and 26 respectively on post-test scores. Similarly, the standard deviation of control group was 3.4 as compared to 1.72, the standard deviation of experimental group. The t-test calculated was found to be significant in favour of experimental group at 0.05 level of significance.

The above table shows the mean, standard deviation and variance of the boys students of both control and experimental groups. The average score of the experimental group was found to be higher than that of the control group. The calculated t-value is 4.225.

Which is greater than the tabulated value 2.306 at 0.05 level of significance. This shows that the null hypothesis is rejected and concluded that there is significance difference between the achievement of experimental and control group boys in post test.

Comparison of Mathematics Achievement of Girls between Control and Experimental Groups.

The achievement score of control and experimental groups of girls were compared to find out effectiveness of problem solving method. The results of mean, variance and t-value are given in the following table:

Table 4.3

Comparison of Girls Mathematical Achievement Score between Control and Experimental Group in Post-test Result

Group	N	Mean	S.D.	Variance	t-value
Control (girls)	6	27.84	4.48	20.07	
Experimental (girls)	7	30.57	4.46	19.89	1.10

It is to be noted that the girls from experimental and control groups obtained mean score as 27.84 and 30.57 respectively on post-test scores.

The above table shows the mean value, standard deviation and variance of the girl students of both control and experimental groups. The average score of the experimental group was found to be higher than that of the control group. The calculated t-value is 1.10. The t-test value shows that there was not any significant difference between experimental and control groups.

Comparison of Mathematics Achievement Score between Control and Experimental Group in Post-test Result

The post-test score of students of control and experimental group students involves in the calculation of mean and variance. The mean, variance and calculated t-value between two groups on the pre-test result is presented in the following table

Table 4.4

Comparison of Mathematics Achievement Score between Control and

Experimental Group in Post-test Result

Group	N	Mean	S.D.	Variance	t-value
Control	11	27	4.13	17.05	3.09
Experimental	12	32.33	4.14	17.21	

The above table shows that the average difference scores and standard deviation of experimental group was found to be higher than the control group in post-test result. The mean of experimental group was 32.33 as compared to the mean value 27 of control group. Similarly, the value of standard deviation of experimental group was 4.14 whereas the control group had only 4.13 in post-test result. The calculated t-value is 3.09. Which is greater than the tabulated value 2.080 at 0.05 level of significance. This shows that there is significance difference between the achievement of experimental and control group in post test.

Therefore, the null hypothesis stating there was no significant difference of mathematic achievement between the two groups was rejected. It means, the difference of means was found significant. In this way, the achievement level of the students of experimental group was found to be satisfactory than that of the students of control group.

Qualitative Data Analysis

The qualitative data of present study was collected and analyzed with the nation of pluralism. Basically the qualitative data were taken to support the result obtained from the quantitative data. The qualitative data includes responses of the students whom the researcher taught for 14 days for her research purpose, the interviews taken with these students and their mathematics teacher etc. During the

researchers' class, the students responded to the researcher very positively . In her observation of the classroom activities of the students the researcher found them to be very active and energetic about learning mathematics using experimental verification the responses given by the students of experimental group in their interviews also show their positive altitude towards using to experimental verification in learning Arithmetic. In response to the first question asked to them, they answered positively similarly when asked about how they had felt after being taught with experimental verification design most of them answered that they had started to feel mathematics as an interesting and curious subject to study.

They said that they had achieved better in the research class due to their direct involvement in experimental verification.

Participation

Observation is a kind of tools that helps to seek knowledge through the uses of sense i.e. eyes, earns, nose tongue and skin. It has great importance not only in research work but also in our daily lives. K.C. (2000) writes that direct observation has the advantages of putting researchers into first hand contact with reality. Participant observation is a close and full involvement of researcher in a natural setting in order to experience and understand the behavior interaction event and so on. it helps to bridge and share the intimacy between the researcher and the setting which is under study by immersing researcher him/herself into the subject being studied. In the experimental group student took participate in leaving, the activates of student participant with teacher were well. It has been playing the key role to produce such a extra ordinary results.

Before the teacher used to solve   the mathematical problem in the black board and we used to copy so we have to remember all the problem. But now we

34

know to understand the mathematics problem and to solve the principal and definition to solve mathematics problem step by so we have developed encourage learning mathematics . Student's view

Regularity

In this study regularity means to students always come to study in school. In experimental group students always comes school to study. The researcher always writes daily notes, daily attendance and checked daily homework of students.

Albina's said that " before all students didn't know to solve the mathematics problems and the teacher used to teach another chapter we did not do home work. There were many mistake in home work. So we did not always learn to go school. But now, we learned to solve mathematics problem and we learn, new method. We learn to solve mathematics problem first of all we understanding the problem and make a plane to solve by discussing with friends and interaction with teacher. so, we felt easy to solve mathematics problem and we come always to study in school.

Chapter V

SUMMARY, FINDINGS, CONCLUSION AND RECOMMENDATIONS

This chapter presents in the summary, findings and conclusion of study to improve the achievement level of problem solving methods in teaching mathematics. Besides findings and conclusion, some recommendations have been forwarded which will be useful for further studies and educational implications.

Summary

Among the different subjects, mathematics plays a vital role in individual daily life and equally in school level to university level education. This study was focus on the mathematical achievement between gender variance, and control and experimental variances. This study also explores the effectiveness of problem solving method in teaching arithmetic in school level. Before and after the experiment both pre-test and post-test were administered respectively. The scores obtained from both tests were calculated and analyzed to obtain the findings of the study.

To compare the achievement score of the students taught by problem solving method and by using traditional teaching method. The population of this study consisted of all ninth grade students of government school of Kathmandu district.

The population of the study includes the ninth grade students of government school of Kathmandu district. The students were kept in two groups as experimental group and control group. The experimental group was given due attention with various experiment whereas the control group was taught using as usual traditional method. The test scores were calculated and analyzed in terms of their mean, variance and t-value.

The main objective of this study was to compare the achievement score of the students taught by problem solving method and by using traditional teaching method in secondary level. For the achievement of the study, the research developed an achievement test and various tools such as mean, variance standard deviation and t-test. The mean and variance of t-test were used to compare the mathematics achievement between genders. The standard deviation and variance were used to test the homogeneity of the test and analyzed the qualitative data. The effectiveness of achievement difference between the experimental and control groups as well as between boys and girls was also analyzed on the basis of interview as well as opinion from students, mathematics teacher and guardians. The researcher analyzed the affective factor as qualitative analysis in discipline way into different variables.

Findings of the Study

On the basis of analysis and interpretation of the data, the researcher was able to draw the following major findings of the study:

- The study proved that the mean score of the students of experimental group was higher than that of the control group. It shows that the mean score of the students taught by using problem solving method was significantly better than that of the students taught by using traditional method.

- The mean difference was not significant in the gender of both experimental and control group. So, it was found that there was no significant difference between the genders in learning mathematics.

- The students of experimental group were found to be more motivated and encouraging while learning mathematic problems than that of the control group. It means, the experimental method was more effective than that of the usual traditional method.

37

- The classroom environment was more friendly to learning among the experimental group as compared with the students of control group. This also shows the effectiveness of the experiment on the problem solving method than that of the traditional method in mathematic teaching.
- The active participation, punctuality and regularity in school as well as submitting assignment of the students of experimental group was found to be higher than that of the students of control group.

Conclusion

The statistical analysis of achievement of the students of experimental group and control group gave some precious conclusion. Discussing the opinions of students, teacher and guardians, the researcher comes up on some conclusion related to fleeting factors of achievement differences in mathematics. On the basis of the findings some very significant conclusions are given.

The ability of gender variation in learning mathematics is similar, however, it was found more satisfactory in problem solving method as compared to the traditional method of teaching mathematic. The problem solving method helps the students to better understanding in mathematics and as a result they performed better achievement than that of the implementation of the usual traditional method. The other aspects such as motivation, comprehension, interaction with the teacher, positive attitude towards learning, application of mathematical tools and formula were found more effective among the students who were taught by using problem solving methods than that of the students who were taught by using as usual traditional methods in teaching mathematics.

Recommendations for Better Learning

On the basis of the findings, the researcher recommended some measures for the betterment of teaching mathematics in secondary level. The recommendations are as follows:

- Active participation in classroom activities should be encouraged.

- The teacher should be trained and frequent training to the teachers should be emphasized.

- The mathematics teacher should be encouraged to use problem solving method while teaching arithmetics.

- The teacher training institutions should emphasize on problem solving method of teaching mathematics.

- The teacher should let the students to discover the answer of the given question on their own way instead of teacher answer.

- The textbook writer, curriculum designer, policy maker should emphasize on problem solving method while making policy, and designing curriculum and textbooks.

- Suitable teaching aids and materials should be used during the process of mathematic teaching.

- Teaching module should be highly technical to assist teaching and learning mathematics. So, teachers should be encouraged to use daily lesson plan and effective teaching materials.

Recommendations for further Study

Since this study was limited in several aspects, the finding of this study can be generated for Kathmandu district but cannot be generalized to all level and all over

the world. So, considering the limitation, the following recommendations have been made:

- This study has been done only on mathematical achievement scores of class nine students. So a similar study should be replicated in other subjects.

- It can be generalized for Kathmandu district but cannot be generalized all over the country. So it is suggested to carry out separate nationwide research.

- Further study should be conducted with larger samples size. Complete random samples are needed in order to obtain more valid finding for broader generalization.

- The score of the students of experimental group was found more better than that of control group. So, teacher should be trained and teaching should be managed properly for their better outcomes.

- In order to create consistency in score, the students should be taught through problem solving methods and traditional rote learning should be discourage.

- Resources, materials and qualified teacher are not easily available in schools. So, there should be easy access to these in the public schools.

- Daily lesson plan, effective teaching materials and internal assessment should be introduced by the concerned authority. This could bring better performance and outcomes among the school students.

REFERENCES

Bell, F. H. (1978) . *Teaching and learning mathematics in secondary school*. W.M.C. Brown company publisher, U.S.A.

Dewan, Y. (2011). *Effectiveness of problem solving method in teaching airthmetics at grade VI.* An unpublished M.Ed. thesis, TU, Kathmandu.

Education in Nepal, (1956). *Bureau of Publications College of Education*, Government of Nepal, Kathmandu.

Educational Statistics of Nepal, (1998). *HMG Ministry of Education, Planning Division, statistics   and computer section*, Keshar Mahal, Kathmandu.

HMG, (2050). Secondary School Curriculum, Kathmandu: Ministry of Education HMG/ Nepal.

Howson, A. G. (1973). *Development in mathematical education*. New York: Cambridge University Press.

Housen and Postlethwaite (1985). *An Encyclopedia of Education,* Volume-6. Pergaman Press Ltd, Heaingion Hill Hall England.

Kandel, K. P. (2007). *A study on effectiveness of teaching problem solving approach on mathematics achievement at grade seven*. An unpublished M.Ed. thesis, T.U, Kathmandu.

National Council of Teachers of Mathematics (1980). *An Agenda for Action Reston VA*. NCTM.

National Education System Plan for 1971-76: Ministry of Education, HMG.

Pandit, R. P. (2007). *Teaching Mathematics in Secondary level*. Ananta Publication Nepal.

Parajuli, M. (2009). *Effectiveness of teaching mathematics by using the problem solving method in teaching mathematics at secondary level.* An unpublished M.Ed. thesis, TU, Kathmandu.

Paudel, S. (2014). *Effectiveness of problem solving methods in teaching mathematics in Syangja district*. An unpublished M.Ed. thesis, TU, Kathmandu.

Polya, G. (1945). *How to solve it*? (2nd Ed). New Jersy: Princeton University Press.

Quaiyam, A. (2003). *A study of students problem–solving behaviours in mathematics at secondary level of Nepal*. (Unpublished Doctoral dissertation) Institute of Advance Studied in Education, University of Lucknow, India.

Report of the Higher Level National Education Commission (1998): HMG, MOEC Nepal.

Report of the National Education Commission, (1992). HMG, MOEC Nepal.

Secondary School Curriculum (1998): His Majesty's Government, Ministry of Education curriculum development center.

Sidhu, K. S. (1982). *The teaching of mathematics*. Starting publishers private limited New Delhi.

Subedi, R. (2010). *Effectiveness of problem solving method in teaching mathematics at lower secondary level*. An unpublished M.Ed. thesis, T.U., Kathmandu.

Sylvester, J. (2010). Retrieved on Dec 2012. From http://www.google/ ethnomathematics.

William and Schaaf, L. (1985). *Basic concepts of elementary mathematics,* New York: John Wiley and Sons Inc.

Yadav, T.C (2008). *Effectiveness of problem solving method in teaching mathematics at grade VIII*. An Unpublished M.Ed. thesis, T.U. Kathmandu.

Appendix A

Statistical formula used for analyzing the data are as follows:

$$\text{Mean (x)} = \frac{\Sigma x}{N}$$

$$\text{Standard Deviation (s)} = \frac{\Sigma (x - \bar{x})^2}{N}$$

$$\text{Pooled Variance(Sp)} = \sqrt{\frac{(N_1 - 1)S_1^2 + (N_2 - 1)S_2^2}{N_1 + N_2 - 2}}$$

$$t = \frac{(\overline{x_1} - \overline{x_2}) + (\mu_1 - \mu_2)}{SP \sqrt{\frac{1}{N_1} + \frac{1}{N_2}}}$$

Where,

x = Mark obtained by students in achievement test

N = Number of students

x = Mean score of sample students

x_1 = Mean score of first sample students

x_2 = Mean score of second sample students

N_1 and N_2 = Number of students of first and second sample

S_1 = Standard Deviation of first sample

S_2 = Standard Deviation of second sample

Marks Obtained in Pre-test and Post-test Achievement Test (School - A)

oll o.	Obtained Marks		Difference between Post-test Pre-test
	P re-test	Post -test	
	3 5	35	0
	2 9	34	5
	2 5	30	5
	2 0	30	10
	2 5	31	6
	2	25	5

	0		
8	1	22	4
9	1	22	3
0	2 2	30	8
2	2 1	28	7
3	1 7	22	5
4	1 5	20	5
5	1 6	19	3
6	1 7	23	6
Number of students who obtained marks between		11	

17-33.	
Roll No. of selected students	2,3,4,6,7,8,9,10,12,13,16
Roll No. of selected boys	4,7,8,10,16
Roll No. of selected girls	2,3,6,9,12,13

Appendix C

Marks Obtained in Pre-test and Post-test Achievement Test (School - B)

oll o.	Obtained Marks		Difference between Post-test Pre-test
	Pre-test	Post-test	
	34	38	4
	30	36	6

	29	37	8
	28	34	6
	27	33	6
	28	34	6
	15	24	9
	25	33	8
0	18	30	12
1	17	28	11
2	20	32	12
	2	30	10

4	0		
5	2 1	31	10
6	1 4	27	13
8	2 0	22	2
Number of students who obtained marks between 17-33.			12
Roll No. of selected students			2,3,5,6,7,8,9,10,11,12,14,15,18
Roll No. of selected boys			2,5,9,12,15
Roll No. of selected girls			3,6,7,10,14,17,18

Appendix D

A. Achievement Score of Pre-test Result (Control Group)

S.N.	Roll No.	Marks(x)	d=$\bar{x}$-x	d²=($\bar{x}$-x)²	
	2	29	7.82	61.15	
	3	25	3.82	14.59	Mean($\bar{x}$)= 21.18
	4	20	-1.18	1.39	Standard deviation(σ)= 3.16
	6	25	3.82	14.59	
	7	20	-1.18	1.39	Variance(s²)= 9.98
	8	18	-3.18	10.11	
	9	19	-2.18	4.75	
	10	22	0.82	0.67	
	12	21	-0.18	0.03	
10	13	17	-5.18	26.83	

S.N.	Roll No.	Marks(x)	d=$\bar{x}$-x	d²=($\bar{x}$-x)²	
1	16	17	-5.18	26.83	
Total	N=11	Σx=233	------	Σd²=162.33	

B. Achievement Score of Pre-test Result (Experimental Group)

S.N.	Roll No.	Marks(x)	d=$\bar{x}$-x	d²=($\bar{x}$-x)²	
	2	30	6.42	41.21	
	3	29	5.42	29.37	Mean($\bar{x}$)= 23.58
	5	28	4.42	19.53	
	6	27	3.42	11.69	Standard deviation(σ)= 4.49
	7	28	4.42	19.53	
	9	25	1.42	2.01	Variance(s²)= 20.23
	10	18	-5.58	31.13	
	1	17	-	43.2	

S.N.	Roll No.	Marks(x)	d=x̄-x	d²=(x̄-x)²	
	1		6.58	9	
	12	20	-3.58	12.81	
10	14	20	-3.58	12.81	
11	15	21	-2.58	6.65	
12	18	20	-3.58	12.81	
Total	N=12	Σx=283	------	Σd²=242.84	

Appendix E

A. Achievement Score of Post-test Result (Control Group)

.N.	Roll No.	Marks(x)	d=x̄-x	d²=(x̄-x)²	
	2	34	7	49	
	3	30	3	9	
	4	30	3	9	**Mean(x̄)= 27**
	6	31	4	16	

S.N.	Roll No.	Marks(x)	d=$\bar{x}$-x	d²=($\bar{x}$-x)²	
	7	25	-2	4	**Standard deviation(σ)= 4.13**
	8	22	-5	25	**Variance(S²) = 17.09**
	9	22	-5	25	
	10	30	3	9	
	12	28	1	1	
0	13	22	-5	25	
1	16	23	-4	16	
otal	**N =11**	**Σx=297**	**------**	**Σd² =188**	

B. Achievement Score of Post-test Result (Experimental Group)

S.N.	Roll No.	Marks(x)	d=$\bar{x}$-x	d²=($\bar{x}$-x)²	
	2	38	5.67	32.14	

					Mean($\overline{x}$)= 32.33
	3	36	3 .67	6	13.4
	5	37	4 .67	0	21.8
	6	34	1 .67		2.78
	7	33	0 .67	89	0.44
	9	34	1 .67		2.78
	1 0	33	0 .67	89	0.44
	1 1	28	- 4.33	4	18.7
	1 2	32	- 0.33	89	0.10
0	1 4	30	- 2.33		5.42
1	1 5	31	- 1.33		1.76
2	1 8	22	- 10.33	70	106.
	N	**Σ**		**-**	**Σd^2**

Standard deviation(σ)= 4.14

Variance(s^2)= 17.21

otal	=12	x=388	------	=206.58	

Appendix F

Achievement Score of Boys and Girls of Experimental Group

A. Achievement Score of Post-test Result of Boys (Experimental Group)

.N.	Roll No.	Marks(x)	$d=\bar{x}$-x	$d^2=(\bar{x}$-x$)^2$	Mean($\bar{x}$)= 33.2
	2	36	2.8	7.84	
	5	34	0.8	0.64	Standard deviation(σ)= 1.72
	9	33	-0.2	0.04	Variance(s²)= 2.96
	12	32	-1.2	1.44	
	15	31	-2.2	4.84	
	N	Σ	-	Σd²	

55

otal	=5	x=166	------	=14.8	

B. Achievement Score of Post-test Result of Girls (Experimental Group)

S.N.	Roll No.	Marks(x)	d=x-x̄	d²=(x̄-x)²	Mean(x̄)= 30.57
	3	37	6.42	41.21	Standard deviation(σ)= 4.46
	6	33	2.43	5.90	
	7	34	3.43	11.76	Variance(s²)= 19.93
	10	30	-0.57	0.32	
	11	28	-2.57	6.60	
	14	30	-0.57	0.324	
	1	22	-	73.4	

56

	8		8.57	5	
otal	N =7	Σ x=214	- ------	Σd² =139.57	

Appendix G

Achievement Score of Boys and Girls of Control Group

A. Achievement Score of Post –test Result of Boys (control Group)

.N.	R oll No.	M arks(x)	d =$\bar{x}$-x	d²=($\bar{x}$-x)²	Mean($\bar{x}$)= 26
	4	30	4	16	**Standard deviation(σ)= 3.40**
	7	25	1	1	
	8	22	4	16	**Variance(s²)= 11.60**

57

	10	30	4	16	
	16	23	3	9	
otal	N =5	Σ x=130	------	Σd² =58	

B. Achievement Score of Post –test Result of Girls (Control Group)

.N.	R oll No.	M arks(x)	d =$\bar{x}$-x	d²=(x-x)²	Mean($\bar{x}$)= 27.84
	2	34	6 .16	38.0 2	
	3	30	2 .16	4.66	**Standard deviation(σ)= 4.48**
	6	31	3 .16	9.98	
	9	22	- 5.84	34.1 0	**Variance(s²)= 20.14**
	1	28	0	0.02	

	2		.16	5	
	1 3	22	- 5.84	34.1 0	
otal	**N =6**	**Σ x=167**	**- ------**	**Σd² =120.88**	

Appendix H

TEACHING MODULE I

Subject   : Mathematics   Date:

Topic   : Unitary Method   Class: 9

Sub - topic: Introduction   Time: 45 min

Specific Objective

59

At the end of this class the students will be able to define unitary method with examples.

Teaching Materials

Daily used teaching materials.

Introduction

The teacher introduces the topic to the students and asks the students if they know something about the topic.

Teaching Learning Activities

i. Understanding the Problem

Review the pre-requisite knowledge and discuss about unitary method with students. The following questions will be asked to students to make them understand the problem:

a. What is unitary method?

b. Do you know the meaning of direct and indirect variations?

After this the teacher writes an example on the board related to the topic and tries to make the concept of unitary method clear to the students.

For Example: If 20 pens cost Rs. 800, how much do 25 pens cost?

a. Do you understand the given problem?

b. Which type of variation can we use?

c. What information do you obtain from the problem?

ii. Thinking of a Plan

In this section the following questions will be asked to the students to guide them to think of the plan:

a. If there is any resemblance with that you solved already?

b. What is given in the problem?

c. What is to find out?

d. What method should be applying to carry out this problem?

iii. Carrying out Plan

After understanding and making plan, the problem stimulates them to seek the way of solving problem for solution:

20 pens cost Rs. 800

1 pen costs Rs. $\frac{800}{20}$

25 pens cost Rs. $\frac{800}{20} x 25$ = Rs. 1000

This method is called unitary method. If the students can't do it, the teacher will give some other clues.

iv. Looking Back

a. Can you say this answer is correct?

b. Are there any alternative methods to find the solution?

c. Is the solution every step should be checked up?

In this way, the teacher can teach the same types of problems.

Evaluation

The teacher asks the following questions to evaluate the students:

a. If 20 pens cost Rs. 800, how much do 25 pens cost?

b. If a book costs Rs. 100, how much do 13 books cost?

c. If a man earns Rs.750, how much do 17 men earn?

Homework

Solve the similar types of another problem from your notebook.

TEACHING MODULE II

Subject   : Mathematics   Date:

Topic   : Unitary Method   Class: 9

Sub - topic: Indirect variance   Time: 45 min

Specific Objective

At the end of this class the students will be able to find the solution of the problems related to the indirect variance.

Teaching Materials

Daily used teaching materials.

Teaching Learning Activities

i. Understanding the Problem

In this section the teacher will do the following activities:

a. Recall the previous lesson by giving a question and if necessary, help them to find the answer.

b. Write an example on the board related to the topic by taking example and make them the concept about the indirect variance.

c. Ask questions such as: do you understand the problem?

d. Ask them to read problem and state it in their own words. Ask questions as

What is given?

What is to find the problem?

e. If the students can't response appropriately the teacher will give them time to consider and make them aware by questions.

ii. Thinking of a Plan and Carrying out Plan

In this section the teacher will stimulate the students to search the way of solving problem.

For example: If 6 men can do a piece of work in 6 days. How many days can 15 men do that work?

For solution ask them, in how many days 1 man can do whole work and why? In how many days can 15 men do the whole work and why? Guide them to find the

solution. After solution ask them can you examine each step of the problem? Are these steps correct ?

iii. Looking Back

In this step, the students will be given to examine whether it has been solved by another means or not. Which method is the most appropriate among them to identify? Ask students to consider the things.

Evaluation

The teacher asks the following question to evaluate the students:

A and B can do a piece of work in 16 days. A alone can do it in 24 days. They both worked together for 9 days then A left. In how many days can B do the remaining work?

Home Work

Solve the problems given in the exercise.

TEACHING MODULE III

Subject   : Mathematics   Date:

Topic   : Unitary Method   Class: 9

                                                       Time: 45 min

Specific Objective

At the end of this class the students will be able to find the amount if the separate amounts are given for two objects.

Teaching Materials

Daily used teaching materials.

Teaching Learning Activities

i. Understanding the Problem

❖ Recall the previous lesson by giving a question and help them to find answer if it is necessary.

❖ Write an example on the board related to the topic.

For example: If Kamala can do a piece of work in 60 days. Sabin can do it in 45 days. In how many days do they can complete if they work together.

❖ For the activity, the teacher will ask the students following question to restate the problem: Do you understand all the words of questions?

❖ The teacher will command them to state their own words as

      a. What is given and what is to find out?

      b. What are you asked to find or show?

      c. Is there enough information to enable you to find a solution?

❖ If the students can't response appropriately the teacher will give them time to consider and make aware them by asking related questions.

ii. Thinking of a Plan and Carrying Out Plan

After understanding the problem, the teacher will command them as:

      a. In how many days can Kamala do 1 work?

      b. How much work will Sabin do in 1 day?

      c. How much work will Kamala and Sabin do in 1 day?

      d. In how many days will kamala and Sabin complete the whole work?

The teacher will guide them to find out the solution and after solution ask them;

      a. Can you examine each step of the problem?

      b. Are these steps correct?

iii. Looking Back

The teacher will give the students to examine for their inferred answer. The students will find out whether it has been solved by right method or not. It can be solved by another method or not. Which method is the most appropriate and reliable among them to identify the answer.

Evaluation

The teacher asks the following question to evaluate the students:

A and B can do a piece of work in 6 days. A alone can do it in 18days. They both worked together for 5 days then B left. In how many days can A do the remaining work?

Homework

Solve the similar problems from your exercise.

TEACHING MODULE IV

Subject : Mathematics   Date:

Topic   : Unitary Method   Class: 9

Sub - topic: Direct variance   Time: 45 min

Specific Objective

At the end of this class the students will be able to find the solution of problem related to direct variance.

Teaching Materials

Daily used teaching materials.

Teaching Learning Activities

i. Understanding the Problem

Recall the previous lesson by giving the question and help them to find the answer if it is necessary. After this write the example on board related to the topic and ask the following questions:

a. Do you understand the given problem ?

b. What does the problem mean ?

c. What is to find out ?

d. What type of variation is it ?

If the students can't response appropriately then give them to consider and make them aware by asking some related questions.

ii. Thinking of a Plan and Carrying out Plan

In this section, the following questions will be asked to guide the students and think of the plan. If the students can't do it, the teacher will give some clues.

iii. Looking Back

The teacher will give the students to examine for their inferred answer. The students will find out whether it has been solved by right method or not. It can be solved by another method or not. Which method is the most appropriate and reliable among them to identify the answer.

Evaluation

The teacher will ask the following question to evaluate the students:

a. X takes twice as much time as Y and 4 times as much times as Z to finish a work. If they work together they can complete the work in 5.5 days. How long each will take to complete the work?

Homework

Solve the problems given in the exercise.

TEACHING MODULE V

Subject   : Mathematics   Date:

Topic   : Unitary Method   Class: 9

Sub - Topic: Ratio and Proportion   Time: 45 min

Specific Objective

At the end of this class the students will be able to solve problems based on direct and indirect proportion by using chain rule.

Teaching Materials

Daily used teaching materials.

Teaching Learning Activities

i. Understanding the Problem

Recall the previous lesson by giving the question and help them to find the answer if it is necessary. After this write the example on board related to the topic and ask the following questions:

a. Do you understand all the words given in the problem?

b. What does the problem mean?

c. What is to find out?

d. What types of variations do you find in this problem?

ii. Thinking of a Plan

If the students can't response appropriately then give them to consider and make them aware by asking some related questions.

iii. Carrying out Plan

In this section, the following questions will be asked to guide the students and think of the plan. If the students can't do it, the teacher will give some clues.

iv. Looking Back

The teacher will give the students to examine for their inferred answer. The students will find out whether it has been solved by right method or not. It can be solved by another method or not. Which method is the most appropriate and reliable among them to identify the answer.

Homework

Solve the similar problems from your exercise.

TEACHING MODULE VI

Subject   : Mathematics   Date:

Topic   : Percentage   Class: 9

                                                          Time: 45

min

Specific Objective

At the end of this class the students will be able to find the percentage of given

number and number of given percentage.

Teaching Materials

Daily used teaching materials.

Teaching Learning Activities

i. Understanding the Problem

Recall the previous lesson by giving question and help the students to find

answer if necessary. After this write an example on the board related to the topic. Ask

them some questions such as:

   a. Do you understand all the words on the problem?

   b. What is given here?

   c. What is to find in the problem?

The students read the problem and try to state it in their own words. If they can't response correctly, the teacher will give them time to consider and make them motivate by some questions.

ii. Thinking of a Plan and Carrying out Plan

In this section, the teacher commands the students to -

a. find 20% of 1000?

b. How do you find the solution?

c. How can it be solved?

d. How do you find the number?

The teacher will guide the students to find the solution as -

20% of 1000

$\frac{20}{100} x\ 1000$ $= 200$

iii. Looking Back

In this step, the students will be given to examine the problem and the solution. The teacher will ask the following questions:

a. Can you examine each steps of the problem?

b. Are these steps correct?

c. Can you prove each step by appropriate reason?

d. Can you solve this problem by alternative method?

The teacher will ask whether it can be solved by another method or not. Which method is the most appropriate among them to identify? Ask students to consider the things.

Homework

Solve the problem from 1 to 7 given on exercise 3.1.

TEACHING MODULE VII

Subject   : Mathematics   Date:

Topic   : Profit and loss   Class: 9

Time: 40 min

Specific Objective :

At the last of this lesson students will be able to

•   Find profit and loss percentage.

 Teaching Materials.

Daily used teaching materials.

Teaching Learning Activities

i.   **Understanding the Problem**

        Before the begging of today's topic teacher will remind pre-knowledge of the topic by asking question.

• What is profit and loss?

• What is formula of profit and loss percentage?

        Then the teacher will give an example about the profit and loss percentage from given S.P and C.P.

        Now taken example:- A man buys a sari on Rs 960 and sell it in Rs.1200. find his profit percent.

75

ii.   Thinking of a Plan and Carrying out the Plan

After understand the problem and command them to solve problem to make idea about solving problem.

i.e if the actual profit or loss are expressed in the percentage of C.P. they are profit or loss percentage and indentify

profit = SP - CP and

loss = CP – SP

also, from above example

here, Cp= Rs 960, SP= Rs1200

Profit % = ?

We know that,

Profit % = $\dfrac{SP-CP}{CP}\times100$ %

= $\dfrac{Rs.1200-}{Rs.9}$)0%

= 25%

25% is the profit percentage .

Similarly by using Loss % = $\dfrac{CP-SP}{CP}\times100$ %

iii. Looking back

After finding of the solution to the problems. It should be examined whether is it true or not? Whether problem can be solved in various way technique one easy and simple that is the best.

TEACHING MODULE VIII

Subject   : Mathematics   Date:

Topic   : Commission, Taxation and Bonus   Class: 9

Time: 45 min

Specific Objective

At the end of this class the students will be able to

Teaching Materials

Daily used teaching materials.

Teaching Learning Activities

i. Understanding the Problem

Recall the previous lesson by giving question and help the students to find answer if necessary. Then discuss about the definition of commission, taxation and bonus. The teacher will make the students' concept clear by giving some examples as-

What will be the total sales in order to receive Rs. 1200 at the rate of $3\frac{1}{3}$ % as commission?

After this the teacher will ask them some questions such as:

a. Do you understand all the words on the problem?

b. What is given here?

c. What is to find in the problem?

d. Which method should we apply to find the rate of given commission?

e. How can we be completely confirmed about the given problem?

The students read the problem and try to state it in their own words. If they can't response correctly, the teacher will give them time to consider and make them motivate by solving the problem.

ii. Thinking of a Plan and Carrying out Plan

The teacher will ask the following questions to guide the students after understanding the problem.

a. Is there any similarity with that you solved already?

b. How should be it solved?

c. What is given problem?

After asking these questions, the teacher will guide the students to write the solve of the given problem as-

Let the total sales price = x.

Commission = Rs. 1200

Commission rate = $3\frac{1}{3}\%$

Then,

$$3\frac{1}{3}\% \text{ of } x = 1200$$

$$\frac{10}{3x\ 100} \times x = 1200$$

$$x = \text{Rs. } 3600$$

iii. Looking Back

After the students have found the solution regarding the given problem, the teacher will ask the following questions to evaluate them:

a. Are all these steps correct?

b. Did you check every step in the solution?

c. Can you verify each step by giving reasons?

d. Can you solve this problem by using another method?

Homework

Solve the similar problems from your exercise.

TEACHING MODULE IX

Subject : Mathematics   Date:

Topic   : Simple Interest   Class: 9

                                                         Time: 45

min

Specific Objective

At the end of this class the students will be able to:

      i. define the term principle, rate, time and amount.

      ii. solve mixed problems of interest.

Teaching Materials

Daily used teaching materials.

Teaching Learning Activities

i. Understanding the Problem

Review the pre-requisite knowledge and discuss about unitary method with students. The following questions will be asked to the students to help them understand the problem:

      a. What is simple interest?

      b. Do you know the meaning of simple interest?

After this, the teacher writes an example on the board related to the topic. By taking examples, the teacher will make the concept of the students clear about simple interest.

For example:

Calculate the simple interest of Rs. 10,000 for 3 years at 10% per annum.

The teacher will ask the following questions to the students:

a. Do you understand all the words on the problem?

b. What is given here?

c. What is to find in the problem?

d. Which method should we apply to find the simple interest?

ii. Thinking of a Plan

In this section, the following questions will be asked to the students:

a. Is there any similarity with that you solved already?

b. How should be it solved?

c. What is given problem?

d. How do you find the interest?

iii. Carrying out Plan

In this section, the teacher will stimulate the students towards the way of solving the problem.

For solution

$$P = Rs. 10,000$$

$$T = 3 \text{ years}$$

$$R = 10\%$$

We know that,

$$I = \frac{PTR}{100} = \frac{10,000 \ x \ 3 \ x \ 10}{100} = \text{Rs. } 3000$$

iv. Looking Back

The teacher will ask the following questions in this section:

      a. Are all steps of solution correct?

      b. How do you check your result?

Homework

Solve similar problems given in the exercise

Appendix - I

TEST ITEM

PRE-TEST

Class : IX   Date:

Subject : Mathematics   Full Mark :
40

                                                         Pass Mark
: 16

Attempt all the Questions :

Group 'A'   4X (1+1)=8

1 (i) Convert the fraction into percentage 1/3.

(ii) Convert the percentage into fraction 90%.

2 (i) What is profit?

(ii) What is formula of percentage?

3 (i) Find the rate interest of given condition.

P= Rs.10000, I=Rs.2000, T=2 years.

(ii) If p=Rs.5000 and I=Rs.4500, then find Amount(A)= ?

4 (i) Find 3% discount of Rs. 1200.

(ii) If number of copy=5, Total cost= Rs. 25. Then find 1 copy cost.

Group 'B'   4X (2+2)=16

1 (i) 20% of 200, how much ?

(ii) Rita gains 24 marks out of 30 in a exam. What percentage is this?

2 (i) If the cost of 5 T-shirts is Rs.500. Find the cost of 15 such T-shirts.

(ii) Find the principal of the given cases:

I= Rs.320, R= 8%, T= 2 years.

3 (i) A watch which was brought for Rs. 1000 was sold for Rs.800. What will be the loss in percent?

(ii) A cycle costing Rs.1600 was sold for Rs.1800. Find the profit.

4 (i) Find the time of the given cases:

P=Rs.1500, I=Rs.180, R=6%.

(ii) if $77=£44 and Rs.1575=$21. How many pounds (£) will be equal to Rs.4725?

Group 'C'   4X4=16

- A girl gains 14 marks out of 20 in a test. What percentage is that?
- Sarmila sold her coat for Rs.4000 at a loss of Rs.725. How much did she pay for it?
- If Rs.1000 is lent out for 2 years so that the interest earned is Rs.200. Find the rate of interest.
- Sita bought 7kg 500 gram of orange for Rs.255. So how many oranges did she buy for Rs.306 ?

TEST ITEM

POST-TEST

Class : IX   Date:

Subject : Mathematics   Full Mark :
40

                                                              Pass Mark
: 16

Attempt all the Questions :

            Group 'A'   4X (1+1)=8

1 (i) Convert the percentage into fraction 80%.

  (ii) Convert the fraction into percentage 1/4.

2 (i) What is loss?

(ii) What is formula of interest?

3 (i) Find the rate interest of given condition.

P= Rs.20000, I=Rs.4000, T=3 years.

(ii) If p=Rs.6000 and I=Rs.5500, then find Amount(A)= ?

4 (i) Find 5% discount of Rs. 1500.

(ii) If number of pen=5, Total cost= Rs. 50. Then find 1 pen cost.

Group 'B'   4X

(2+2)=16

1 (i) 10% of 500, how much ?

(ii) Ram gains 30 marks out of 50 in a exam. What percentage is this?

2 (i) If the cost of 6 pants is Rs.700. Find the cost of 10 such pants.

(ii) Find the principal of the given cases:

I= Rs.580, R= 5%, T= 1 year.

3 (i) A table which was brought for Rs. 2000 was sold for Rs.1200. What will be the loss in Percent?

(ii) A television costing Rs.1200 was sold for Rs.1500. Find the profit .

4 (i) Find the time of the given cases:

P=Rs.2500, I=Rs.150, R=4%.

(ii) Write the conditions for congruency of triangles.

Group 'C'   4X4=16

- A boy gains 24 marks out of 60 in a test. What percentage is that?

- Meera sold her bicycle for Rs.5000 at a loss of Rs.850. How much did she pay for it?

- If Rs.2000 is lent out for 3 years so that the interest earned is Rs.100. find the rate of interest.

- Rita bought 4kg 600 grams of apple for Rs.580. So how many apples did she buy for Rs.220?

Appendix K

Interview format for key Informants

Name of Student ....

Permanent Address ....

Temporary Address......................................

Age . ...   Sex ....

Roll No.............   Religion ....

The interview with the key respondents was taken in the basis of following main points.

- Personal history

- Family back ground

- Reading opportunity at home

- View s about mathematics

- Views about school environment and teacher's behaviours.

- Mathematics learning style

- Teaching method

- Homework and class work.

Interviewer: ....   Date :

....