

**EFFECTIVENESS OF PROBLEM SOLVING METHOD ON
MATHEMATICS AT GRADE IX**

**A
THESIS
BY
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**IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE
DEGREE OF MASTER IN MATHEMATICS EDUCATION**

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10 March 2021

Letter of Certificate

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Letter of Approval

This thesis entitled **Effectiveness of Problem Solving Method on Mathematics at Grade ix** submitted by **Mr. Prabin Kumar Rayamajhee** in partial fulfillment of the requirements for the Master's Degree in Education has been approved.

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This is to certify that **Mr. Prabin Kumar Rayamajhee** has completed his M.Ed. thesis entitled **Effectiveness of Problem Solving Method on mathematics at Grade ix** 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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Declaration

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

.....

(Prabin Kumar Rayamajhee)

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Defense Date: 10 March, 2021

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Dedication

To My respected parents:

Dhurba Bahadur Raya and Pyari Rayamajhee

Acknowledgement

I would like to graciously thanks several individuals for making the completion of this thesis possible. First and foremost, I would like to thanks my thesis supervisor Mrs. Sarala Luitel. She has provided me with invaluable advice, guidance, insight and encouragement without which this would not be success. Thank you for believing in my ability to create a finished product worth being proud of.

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.....

Prabin Kumar Rayamajhee

Abstract

This study is focused to explore the **Effectiveness of Problem Solving Method on mathematics at Grade ix**. A pre-test and post-test of quasi-experimental research design was used to compare the achievement of two groups experimental and control. The experimental group and control group were selected by coin toss method. The experimental groups were taught by using problem solving method whereas the control group were taught by traditional method. To measure the effectiveness of problem solving method in teaching mathematics, the researcher developed and administered mathematical achievement test for both pre-test and post-test. The test scores were collected and descriptively analyzed by using different mathematical tools as mean, percentage and t-test. The findings of this study were presented after analyzing and interpreting the data. Finally, the researcher suggested recommendations and pedagogical implications. The researcher closed IX grade 39 students of Shree Panchakanya Secondary School, Roshi-10, Kavre as an experimental group and 43 students of Shree Mangal Jana Bijay Secondary School, Roshi-9, Kavre as a control group. After completion of the targeted chapters, researcher collected the data from mathematics achievement test and a set of interview related to the problem solving method. The mathematics achievement test was used for objective; comparing the achievement of the students taught by using Problem Solving method and traditional method and interview was used for objective to explore the students view towards the problem solving method. The results indicated that there was a significant difference between the average achievement score of experimental and control groups on post-test. This finding illustrated that the students in the experimental group performed better when using problem solving method than the control group with the traditional teaching method.

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Abbreviations

AD	: After the Death of Christ
BS	: Bikram Sambat
N	: Number
NCTM	: National Council of Teacher of Mathematics
NO.	: Number
SD	: Standard Deviation
TU	: Tribhuvan University
\bar{X}	: Mean
ICT	: Information and Communication Technology
i.e.	: That is
d.f.	: Degree of freedom
P	: Difficulty level
D	: Discrimination index
F	: F-distribution
t	: t-distribution
r	: Reliability of coefficient
r_{xy}	: Pearson's correlation coefficient
α	: Level of significance
%	: Percentage

Chapter - I

INTRODUCTION

Background of the Study

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 teacher's 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. (Kandel, 2007).

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 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).

There are different methods of teaching mathematics. Nature of subject, classroom size, availability of physical materials, teaching strategies, methods and techniques of teaching have been propounded by educational thinkers. Some of them

are child-center method, co-operative method, individual methods and problem solving method.

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.

Statement of the Problem

In the context of Nepal, the traditional method and technique of teaching do not gives emphasis to creativity, imagination power and reasoning power of students to learn mathematics better and increasing opportunity working in peers. In our secondary level mathematics curriculum, there are so many chapters where we most use problem solving methods like verbal problem, to solve the problem of geometry, to solve the problem of sets etc. Above mentioned facts motivates the researcher to conduct the research on effectiveness of problem solving method while teaching mathematics at secondary level. The study was concerned with the problem solving method and its importance for teaching learning secondary level mathematics. And also this study concerns about the effectiveness of problem solving method at grade IX. Therefore, this research has been initiated and addressing the following statements:

- Does the use of problem solving method more effective than traditional method while teaching arithmetic?
- Differentiating the students view on problem solving method in learning mathematics?

Justification of 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. This study helps to the curriculum designer, specialist and other. And also this study helps new teacher as well as partial trained teacher. This study provides the information about present train of problem solving method at secondary level.

Objective of the Study

The primary objective of this study is to find out the effectiveness of the problem solving method at the secondary level. Further, this objective has been precisely in the following behavioral form:

- To compare the achievement of the students taught by problem solving method and traditional teaching method in mathematics.
- To explore the students view towards the problem solving approach, while learning mathematics.

Delimitation of the Study

This study was delimited under the following ways:

- The researcher of this study has utilized George polya's problem solving method.
- The study was delimited to the two government school of Kavre district.
- In experimental group 39 students of Shree Panchakanya Secondary School were for the study. In which researcher was taught in experimental group by using problem solving method.
- In control group 43 students of Shree Mangal Jana Bijay Secondary School were for the study. In which researcher was taught in control group by using traditional method.
- The experimentation period of this research was based on completion of targeted chapters.
- Achievement test and questionnaire are tools to collect the data.
- Tests have been made by researcher himself with help of subject teacher, expert, and supervisor.

Hypothesis of the Study

Hypothesis means a mere assumption or some supposition to be proved or disproved. It related an independent variable to some dependent variable. The statistical hypotheses were formulated in this study, they are as follows:

Statistical Hypothesis

The null and alternative hypothesis as follow:

- a. **H₀**: There is no significance difference between the average achievement score of experimental and control groups i.e. $\mu_1 = \mu_2$ on pre-test

H₁: The average achievement score of experimental group is not equal to the control group i.e. $\mu_1 \neq \mu_2$ on pre-test

- b. **H₀**: There is no significance difference between the average achievement score of experimental and control groups i.e. $\mu_1 = \mu_2$ on post-test

H₁: The average achievement score of experimental group is higher than the control group i.e. $\mu_1 > \mu_2$ on post-test

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. The steps of problem solving method according to Polya are as below: (Polya, G. 1945)

- Understanding the problems
- Making a plan
- Carrying out the plan
- Looking back

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 measure of effect for this study includes the increase in the average achievement of students in mathematics and students positive view on problem solving method than traditional.

Chapter - II

REVIEW OF RELATED LITERATURE

A review of literature is compact written summary of journal articles, books and the other document that portrays the past and current state of information on research topic which is going to be studied (Creswell, 2014). 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. This chapter deals with the study of the literature related to this study.

Empirical Literature

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 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:

Quaiyam (2003) did the research work on “A study of student's 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 prior 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 took 40 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.

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. (Polya, G. 1945)

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
- Carry 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 saw 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.

Carry 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.

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 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.

Conceptual Framework of the Study

Conceptual framework has been developed on the basis of the previous researchers and studies carried out in the similar topics. In this regard the researcher has consulted researches of various writers and researched. The idea can be present in the following framework. A framework for problem solving method in learning mathematics according to George Polya is:

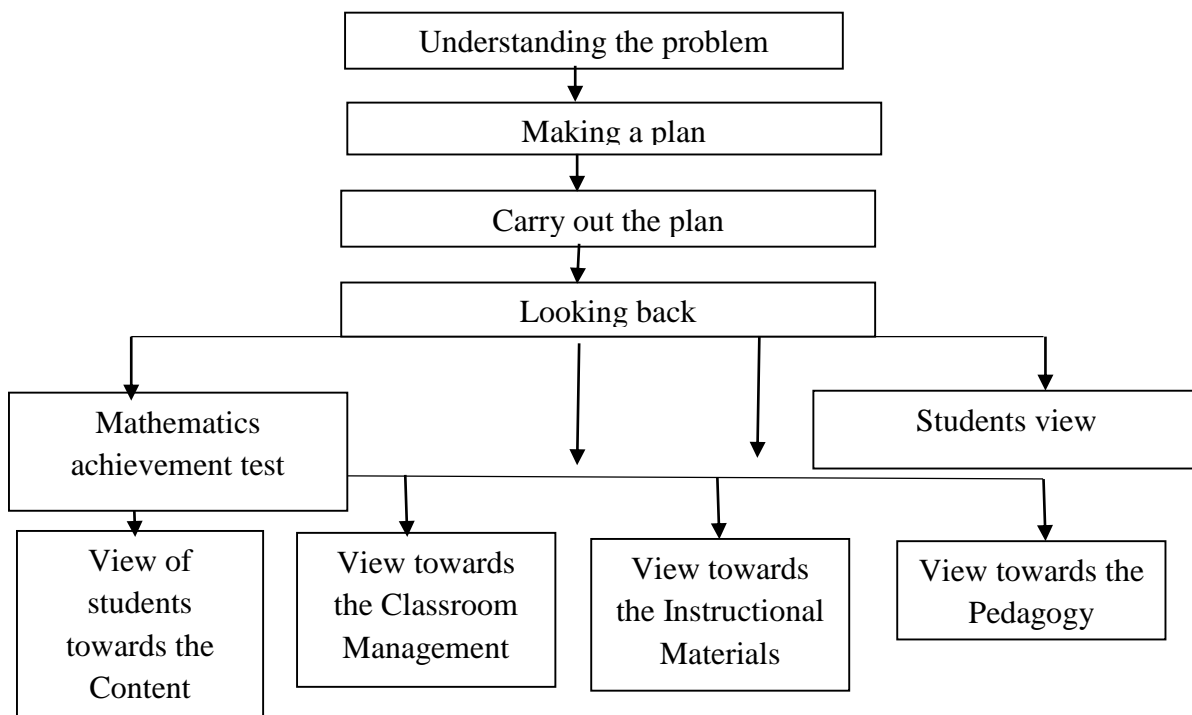


Fig. 1

Source: George Polya (1945)

In 1945 George Polya Published the book *how to solve it* which quickly become his most prized publication in this books hi identifies four basic principles of problem solving method. This seems so obvious that is often not even mentioned, yet students are often stymied in their efforts to solve problems simply because they don't understand it fully, or even in part.

- 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.

Polya mentions that there are many reasonable ways to solve problems. The skill at choosing an appropriate strategy is best learned by solving many problems. You will find choosing strategy increasingly easy.

- 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 saw 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.

This step is usually easier than devising the plan. In general, all you need is care and patience, given that you have the necessary skills. Persist with the plan that you have chosen. If it continues not to work, discard it and choose another. Don't be misled, this is how mathematics is done, even by professionals. Polya (1957)

Polya (1957) mentions that much can be gained by taking the time to reflect and look back at what you have done, what worked, and what didn't. Doing this well enable you to predict what strategy to use to solve future problems.

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 as below:

Design of the Study

Research design is the design of path about how does the research was conduct. It is the detail path of the investigation. Thus, research design comprises the overall strategy followed in collecting and analyzing data (Gay et al., 2012).

To meet the objectives of the study, the researcher used experimental design. According to Gay et al. (2012), in experimental research the researcher manipulates at least one independent variable, controls other relevant variables, and observes the effect on one or more dependent variables. It involves a comparison of two groups like experimental and control group.

Among the various experimental designs, pre-test and post-test design of quasi-experimental design was preferred most in this study because this design is often used in classroom experiments when experimental and control group are naturally assembled groups as intact classes. The design of the study will as follows:

Table: 1 Design of Study

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 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 was not comparable in pre-test scores, the post test scores was taken and compere by using t-test. The researcher was compare the scores for the difference between the two average mean differences.

Variables

Variables are key ideas that researcher seek to collect information on to address the purpose of their study. A concept which can take on different quantitative values is called a variable. Also variables is a characteristic or attribute of an individual or an organization that researcher can measure or observe and varies among individuals or organizations studied (Creswell, 2012).

Different variables used in educational research. An independent variable is an attribute or characteristic that influences or affects an outcome or dependent variable. A dependent variable is an attribute or characteristic that is dependent on or influenced by the independent variable (Creswell, 2012). It means if one variable depends upon or is a consequence of the other variable, it is termed as a dependent variable, and the variable that is antecedent to the dependent variable is termed as an independent variable. Variables that are not related to the purpose of the study, but may affect the dependent variable are termed as extraneous variables (Creswell,2012). The variables in this study were classified as:

- Independent variable: In this study, using problem solving method while teaching problem related to arithmetic is known as independent variable.

- **Dependent variables:** In this study, students' score on mathematics achievement test (post-test) and students view on arithmetic are considered as dependent variables.
- **Extraneous variables:** Selection of school, instructor/teacher, subject matter, group, experimental time, test, scoring, student's labor and home environment are considered as extraneous variables in this study.

Some Major Affecting Variables Controlled in the Experiment

- **Selection of school:** Such two schools were selected by coin toss method for experimental and control group.
- **Instructor/Teacher:** Researcher himself was taught for the experimental and control group.
- **Subject matter:** In experimental period the chapter of arithmetic of grade IX was taught for the both groups.
- **Group:** Experimental and control group of students have been made by naturally assembled.
- **Experimental time:** Researcher had provided equal time to both groups.
- **Test:** Same test paper had conducted for the both groups before and after the time of experimentation.
- **Scoring:** Researcher himself had gave the score of students in text paper appeared by the students.

Some Variables that can't be controlled during the Experiment

- **Student's labor:** Students may labor more or less than expected by the researcher and self-study of the students may affect in the result of research, which is out of control.

Student's home environment: Student's home environment has great effect on student's behavior and attitude but it cannot be controlled by the researcher.

Experimental Stages

Experimental stage was categorised into three stages in this study, which as follow:

Pre-Experimental Stage

In the pre-experimental stage, the researcher developed the test item and questionnaires for interview. Test item included in subjective questions. The interview related to student's view about problem solving method. After developed test items, mathematics achievement test items were piloted on the group of students that are not included in sample for pre-test and post-test. And analysed the result of pilot test and select the pre-test and post-test item of mathematics achievement test. Same pre-test and post-test item was selected. After selected test item of mathematics achievement test, pre-test was administered among the students of experimental and control groups for the purpose of group comparable. The pre-test consisted of 10 subjective questions.

Experimental Stage

In this stage, researcher himself was taught for the experimental and control group regularly four weeks. The experimental group of students was taught by using problem-solving method but the control group of students was taught by using traditional method.

Post-Experimental Stage

In post-experimental stage, the post-test was administered among both groups. The post-test consisted of 10 subjective questions. Also a set of interview was administered only on experimental groups. It consisted 8 statements related to students view about problem solving method for 5 students. After collecting the students answer and response, the data was analyzed.

Intact group for the study

The population of this study consisted of all ninth grade students of government schools of Kavre district. The researcher was select grade IX students since it is the beginning as well as the foundation level of secondary education.

Sample of the Study

This study was experimental study which was carried in two schools: Shree Panchakanya Higher Secondary and Shree Mangal Jana Bijay Higher Secondary School. These two schools was 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 whole students of Grade IX of both schools.

Table: 2 Composition of Sample

Group of Students	No. of Students
Experimental	39
Control	43
Total	82

Tools

For this study, instruments was used for the purpose of data collection. Which are achievement test (pre- achievement test and post- achievement test), daily notes, focus group discussion, interview and observation related to Household Arithmetic, Percentage, Tax and Commission.

Validity and Reliability of Tool

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

To check the reliable of the test, we have to do reliability of the test. Reliability is very important of this study. For this purpose, every test items was piloted and reliability was checked before it was administered. In this study, the mathematics achievement test piloted, involving 84 students of grade IX in Shree Mangal Janavijay Higher Secondary School and Shree Panchakanya Higher Secondary School, Roshi Kavrepalanchok District. The response of the student was analyzed. Employing the split-half method of reliability of the test was determined. The test found to have $r=0.85$ (see Appendix-4). It indicates that the mathematics achievement test was highly reliable.

Achievement Test

The pre-achievement test was administered within both experimental and control group in order to find out the students understanding level. The test was

contain ten items which all are selected in terms of item analysis. Post-performance test containing ten items that was slightly different from pre-test was administered in both group, but parallel in terms of difficulty level. Post-performance tests was used to measure the student's achievement after using Problem Solving Method.

Item Analysis of the Test

In item analysis, the difficulty level (P-Value) and discrimination index (D-Value) of the test was computed to check which item accept for achievement test and also to check quality of the test item. The researcher conducted the pilot test among 25 students of Shree Panchakanya Higher Secondary School. After collected students' response, first divide the total number of students into two groups which were appeared in pilot test by 50% of high scorer students and 50% of low scorer students from total. Out of them choose 27% high scorer students and 27% low scorer students. So, researcher took 7 upper 27% and 7 lower 27% scores students out of 25 students. The table of item analysis of test is given in Appendix-3. By using statistical formula, only those item were selected whose P-Value was ranging between 26% to 74% and D-Value was ranging between 0.20 to 1.00. The other items were rejected and modified. The 3 items were rejected from 10 questions. After cancelling and modifying the items, the refined instrument of achievement test was prepared.

Interview Schedule

In order to elicit students' perception towards problem solving method semi-structured interview containing different related questions. Such interview was completed considering 5 students from experimental group. Statements of interview were given in Appendix 8 these were the sample of guiding interview and the

interview had conducted many ways; formally or informally to collect saturated information.

Observation memo writing

Problem solving method is a method which makes teaching task easier, gives idea about solving problem makes complex problem in simple. This method makes it easier for teacher to teach and student to understand in a better way. By this method, students understand harder concept of mathematics which is not understood by other method. Also it develops the analytical power and idea of solving problem.

Interaction with the teachers before, made the researcher find that students made noise when teacher taught and also found that problem regarding solving techniques. But then the researcher took the class by using the problem solving method, he found quite opposite reactions. The student used to ask him regarding the subject matter, participation and interactive in the class which made the researcher has personal satisfactions in teaching and feel the teaching time passed the very fast.

In conclusion, it was found that the traditional teaching method which did not include any interaction did not use any material and practical technique found to be inactive. But when problem solving method was used in teaching the students were found greater degree of conceptual knowledge about mathematics. From the response of the students, researcher concluded that the students of the experimental group seemed very positive and curious in learning mathematics the students of control group, researcher found that the students were interesting with a mathematics subject, participation in the group discussion and group work. The response from the students,

researcher concludes that the problem solving method in teaching mathematics is far better than the traditional method of teaching.

Intervention

For the intervention, the problem of the arithmetic at grade IX were planned to be taught by using problem solving method to the experimental group. The teacher was the researcher. The traditional teaching method was used by a teacher in the control group. The intervention was preceded by a pre-test, as a baseline (Appendix II). After the pre-test the intended classroom activities were implemented. The classroom teaching, which was the main part of the intervention, covered Household Arithmetic lessons each of which was 45 minute period. At the beginning of intervention, teacher prepared the teaching episode (Appendix -I) .

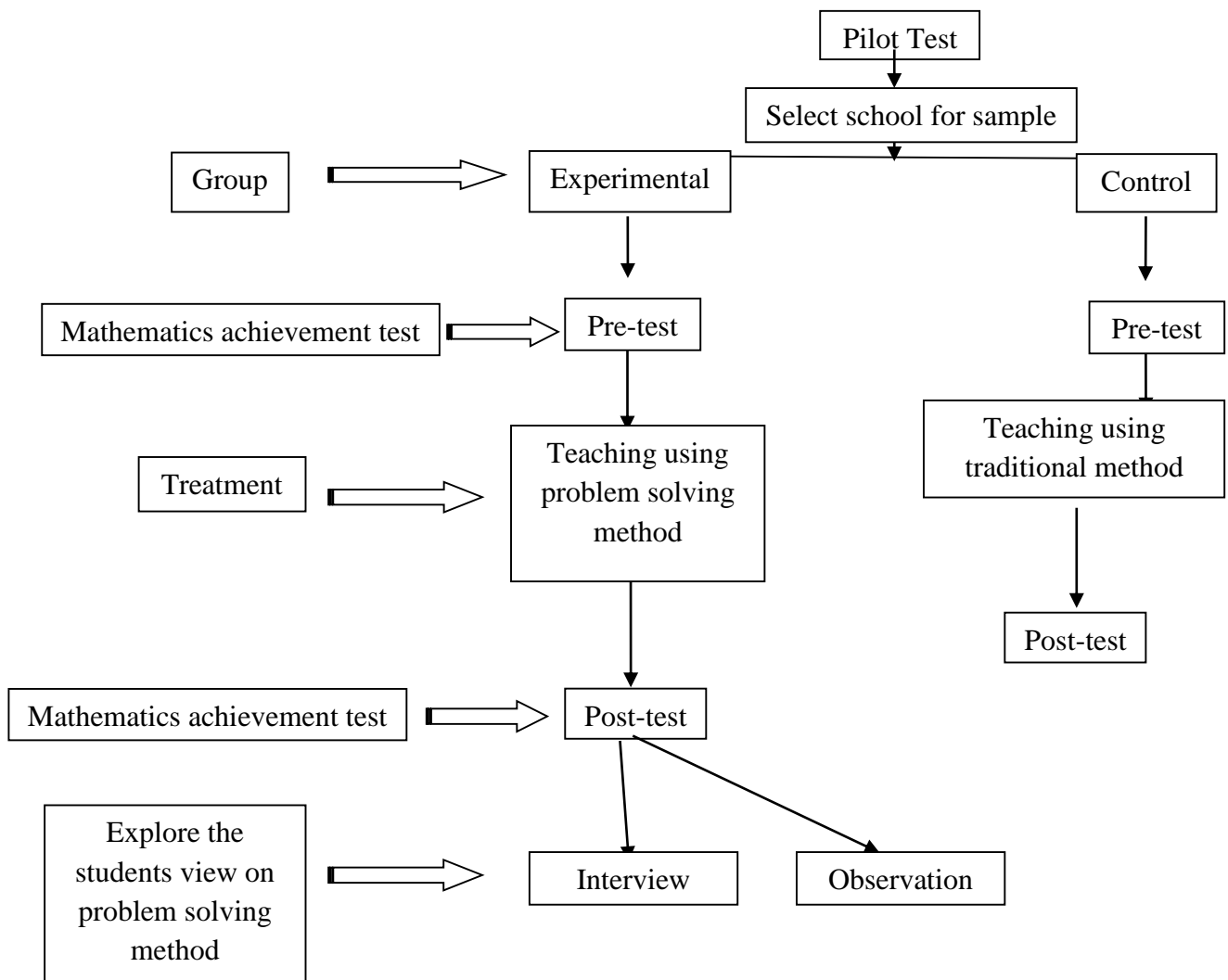
In the first period, first few minutes the teacher introduced to the about problem solving method to the students in the experimental group, and teacher explained the problem related to Percentage. After that researcher/ teacher and students both interaction each other and solved the problem related to household. (See teaching episode-1). These problems to be taught by traditional method in the students of control group.

At the end of the intervention, post-test (see Appendix-2) was administered in both group and interview schedule (see Appendix-8) was administered only the experimental group. Thereafter, in order to evaluated the intervention.

Data Collection Procedure

This study has mainly based on the quantitative data obtains from achievement test and closed form of interview. In the beginning of data collection process pre-test was conducted within both group's i.e. experimental group and control group. Then after, quantitative analysis was completed of the result of pre-test. After experiment, post-test was administered within same groups. After that, quantitative analysis of the result of post-test was calculated. Finally, a closed form of interview was conducted within experimental group only and such information was converted into numerical form using computer.

Figure: 2 A Summary of The Data Collection Procedures



Data Analysis Procedure

The collected data was 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.

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 at Secondary Level" 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 students view towards the problem solving approach. This chapter deals with the analysis and interpretation of data. An experimental research was done in concern to the topic "Effectiveness of Problem Solving Method at Secondary Level". The objectives of the study were 'Comparing the achievement of the students taught by using problem solving method and traditional method and 'Analyzing the students view on problem solving approach. A pre-test and post-test design of quasi-experimental was adopted for the purpose of the study. A pre-test was taken to make the group comparable. Primarily, the achievement test of the students in post-test was taken to fulfil the first objective of the study. And for the second objective of the study, interview were used. The score of the students were analyze using statistical method with help of Microsoft Office Excel 2007 for mean, variance and standard deviation. And the students view on problem solving method were analyze using Microsoft Office Excel 2007 for mean and standard deviation. For fulfill of motto, the data are organized, tabulated, analyzed and interpreted as follow:

Analysis of Pre-Test Result

The pre-test score of students of both groups are presented in Appendix-5. The pre-test was administered for both groups to measure the cognitive level of the students. The summary of statistical calculation for the experimental and control group on the pre-test is given in Table 3 below.

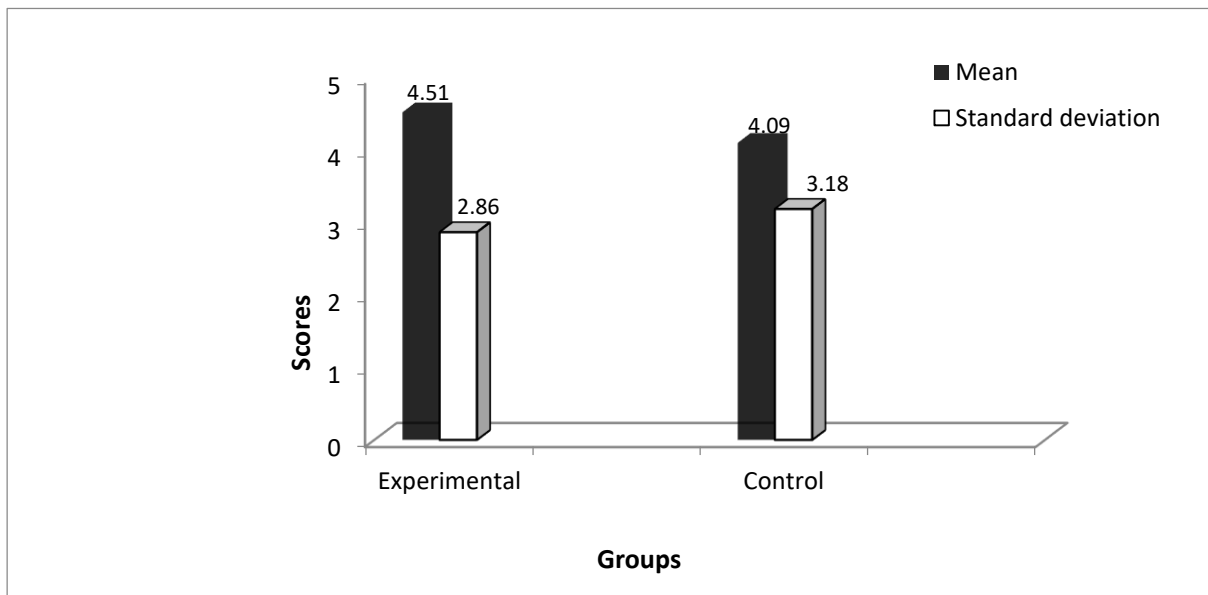
Table: 3 Result of Pre-Test

	Group	
	Experimental	Control
Number of Students	$N_1 = 39$	$N_2 = 43$
Mean	$\bar{x}_1 = 4.51$	$\bar{x}_2 = 4.09$
Variance	$s_1^2 = 8.20$	$s_2^2 = 10.09$
Standard Deviation	$s_1 = 2.86$	$s_2 = 3.18$
F	0.81	
Calculated t-value	1.21	
Tabulated t-value	1.96	

The above Table 3 shows us, there were 39 and 43 number of students in experimental and control group respectively. In pre-test 20 marks of mathematics achievement test was administrated (see pre-test questions in Appendix-2 and pre-test score of students in Appendix-5). The mean, variance and standard deviation of experimental group were 4.51, 8.20 and 2.86 respectively. Similarly, the mean, variance and standard deviation of control group were 4.09, 10.09 and 3.18 respectively. Since the value of F is 0.81, so that two groups were homogeneous

therefore t-test for pooled variance was applied. Here tabulated t-value at $\alpha = 0.05$ level of significance for two tailed test with 80 degree of freedom is 1.96 but calculated t-value was 1.21. Calculated t-value was not lying in critical region i.e. $-1.96 < 1.21 < 1.96$. So H_0 is accepted. Hence it could be concluded that there is no significance difference between the average achievement score of experimental and control groups of pre-test. Thus, both groups were nearly equal in ability.

Figure: 3 Mean and Standard Deviation Scores Distribution of Pre-test Result



The mean and standard deviation scores obtained by the students of each group in the achievement test (pre-test) score have been shown in above diagram (Figure 3). This diagram is more interesting for comparison. This shows that there is no difference in achievement score of both groups of students on pre-test.

Analysis of Post-Test Result

The post-test score of students of experimental and control groups have been presented in Appendix-6 and the summary of statistical calculation for the both groups on post-test is represented in the Table 4.

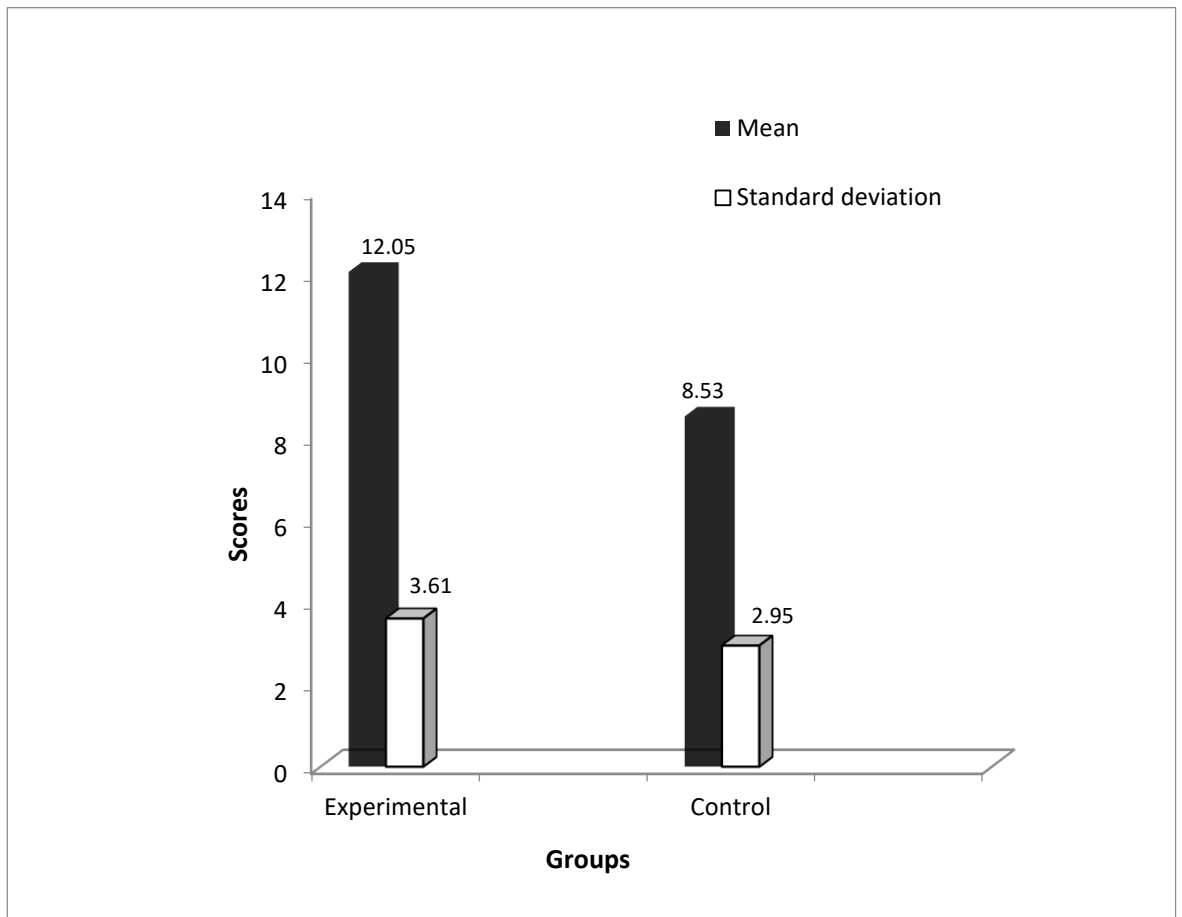
Table 4: Result of Post-Test

	Group	
	Experimental	Control
Number of Students	$N_1 = 39$	$N_2 = 43$
Mean	$\bar{x}_1 = 12.05$	$\bar{x}_2 = 8.53$
Variance	$s_1^2 = 12.99$	$s_2^2 = 8.73$
Standard Deviation	$s_1 = 3.61$	$s_2 = 2.95$
F	1.43	
Calculated t-value	21.97	
Tabulated t-value	1.645	

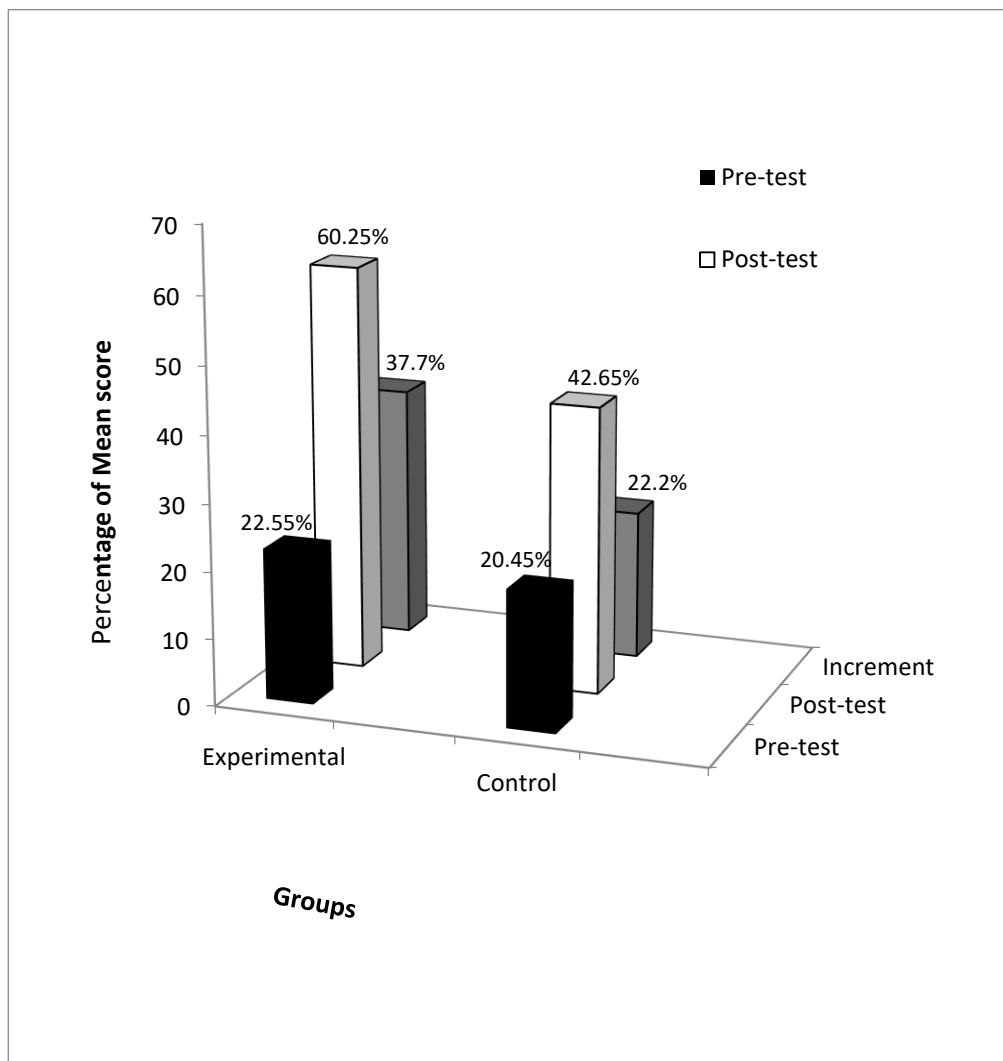
The above Table 4 shows that there are 39 and 43 students in experimental and control group respectively. In post-test 20 marks of mathematics achievement test was administered (see post-test questions in Appendix-2 and post-test score of students in Appendix-6). The mean score of experimental and control group are 12.05 and 8.53 respectively as well as variance are 12.99 and 8.73 respectively. Also standard deviation of experimental group is 3.61 and control group is 2.95. These values were calculated by mathematics achievement test in post-test using Microsoft Office Excel 2007. Since the value of F was 1.43, so both groups were homogeneous hence the method of pooled variance for t-test was applied. Here tabulated t-value at $\alpha = 0.05$ level of significance for one tailed test with 80 degree of freedom is 1.645. But calculated t-value is 21.97. Here $21.97 > 1.645$, so that H_0 was rejected and H_1 was accepted. Hence the average achievement score of experimental group is higher than

the control group on post-test. Thus, the students who were taught by using problem solving learned more and so higher achievement than traditional method of teaching.

Figure 4: Mean and Standard Deviation Scores Distribution of Post-Test Result



The mean and standard deviation scores obtained by the students of each groups in the achievement test (post-test) score have been shown in above diagram (Figure 4). The column of experimental group of students is longer than that of control group students. This shows that there is a difference in achievement score between experimental group and control group on post-test. Since the difference between the mean, standard deviation on the post-test was 3.52 and 0.66 respectively. Therefore, the diagram (Figure 4) indicates that the teaching using problem solving is more effective than traditional method.

Figure 5: Comparison Percentage of Mean Score on Pre-Test and Post-Test

The above diagram (Figure 5) shows that percentage of mean score on pre-test of experimental and control group are 22.55% and 20.45% respectively. But percentage of mean score on post-test of experimental group is 60.25 % and control group is 42.65%. So 37.7% increment in mean score of experimental group but 22.2% increment in mean score of control group. Therefore, percentage of mean score of experimental group is higher than control group of students. Thus, the above diagram shows that the using problem solving is more effective than traditional method.

Analysis of Student view on Problem Solving Approach

In this part of my thesis, the students gave me the positive response about problem solving method. They were excited to reply the answer of the teacher. At first, the researcher has prepared eight questions related to the problem solving method and traditional method too. Then the researcher has taken five students randomly from the experimental group only. They are totally unknown about problem solving method in the previous classes. In the previous classes, they were taught by lecture method, teacher centered method, explanatory method and without using teaching method. Mainly they were not focused about problem. After the focusing the main problem, they were massive familiars with the problem of mathematics task. By this, they were very convenient to solve the problem by step by step. 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. Every student was very excited to learn by the method. They were feeling that there are no any negative aspects of this problem solving method. Every student liked this method with heart. They were suggested to the researcher that every question of the every chapter as well as of their micro problem should be taught by problem solving method. They could not understand at all by traditional method. They were feeling nervous day by day with the previous method. Mathematics was being very harder and harder day by day. They have been feeling that, the only 45 minutes

class is also like one day. They loved this method very much. They pointed so many differences about traditional method and problem solving method. They are totally biased the traditional method. They suggested that the every subject should be taught by taught by problem solving method. Especially they loved the steps of the problem solving method.

In this part of my thesis students gave me the positive respond about problem solving method. Students are very excited to reply the answer of the teacher. In this previous classes, they were taught by teacher centered method, lecture method, explanatory method and without using teaching material. Students interview as below:

"I am excited in classroom I like Problem solving method. we are very convenient to solve the problem by step by step and we gain knowledge by step to step."

- Student A view

From the response of the student, researcher concluded that the students of the experimental group seemed very positive and curious in learning mathematics. Student are very convenient to solve the problem by step by step.

"We are hard to understand the traditional method but Problem solving method is useful to learning mathematics and understanding problem. Traditional method is hard and boring to learn mathematics"

- Student B view

Tradition method is passively listen to teacher lecture and see the solution of the problem on the board. This modality of teaching learning is also considered conventional method of teaching. But problem solving method is solving the problem in which it solve the problem step by step and it makes easy to both the teacher and student to teach and understand.

"Problem Solving method is gave us positive energy to solve mathematics and positive motivation. This method we suggested that every subject should be taught by problem solving method because we loved the steps of the problem solving method."

- Student C view

The response from the student researcher concludes that the problem solving method in teaching mathematics is far better than the traditional method of teaching.

The observation analysis shows that the problems on mathematics teaching learning are lack of teaching materials such as teacher's guide, books and instructional materials, lack of learning management in classroom, lack of explanation of terms, not giving feedback and suggestion to improve in mathematics learning. Teacher focus mainly lecture method, teacher centered method and explanatory method.

Review Connections

In this study, the teaching and learning of arithmetic at secondary level has been effective. This was shown through the improved scores of the students in experimental group. The finding highlighted that students in experimental group performed better using the Problem Solving method than the control group that uses the traditional method. Students in the experimental group performed better in the

post-test compared to the control group. Students generally gave positive feedback or view about the Problem Solving method while teaching arithmetic at secondary level.

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 control and experimental variances. This study also explores the effectiveness of problem solving method at secondary 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 IX grade students of two government schools of Kavre 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 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 was also analyzed on the basis of interview as well as opinion from students. 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:

- There was no significant difference between the average achievement score of experimental and control groups on pre-test.
- There was significant difference between the average achievement score of these groups on post-test i.e. the average achievement score of experimental group was higher than that of control group.
- The teaching using problem solving method was more effective than traditional method in arithmetic at secondary level.
- 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.
- 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.

- The results show that students gave positive feedback or view about the problem solving method.

Conclusion

In this study, the teaching and learning of arithmetic at secondary level has been effective. This was shown through the improved scores of the students in experimental group. The finding highlighted that students in experimental group performed better using the problem solving method than the control group that uses the traditional method. Students in the experimental group performed better in the post-test compared to the control group. Students generally gave positive feedback or view about the problem solving method while teaching arithmetic at secondary level.

Recommendations for Further Study or Educational Implication

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 arithmetic.
- 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 Kavre 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 IX students. So a similar study should be replicated in other subjects.
- It can be generalized for Kavre 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 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.

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Appendix - 1

Teaching Episode - 1

Subject : C. Mathematics

Topic : Household Arithmetic (Exercise: 4.1, household expenses for use of electricity)

Duration of lesson: 45 minutes

Class : IX

Teacher : Prabin Kumar Rayamajhee

School : Shree Panchakanya Secondary School

1. Specific Objective:

At the end of this class the students will be able to check their electricity bills of any institution and calculate the total amount have to pay.

2. Teaching Materials:

Daily used teaching materials, electricity bills

3. Teaching Learning Activities:

Problem: The current reading and previous reading of Gopal's house of electricity is given below. Find the total utilize unit and calculate to amount have to pay.

Current reading = 3697

Previous reading = 3568

For 10 minutes:

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 and the teacher shows electricity bills and explains.

For 20 minutes:

ii. Thinking of a Plan and Carrying out Plan:

In this section, the teacher commands the students to -

- a. What may current reading mean?
- b. What may previous reading mean?
- c. How can it be solved?
- d. How can you calculate the amount?

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

$$\begin{aligned} \text{Utilize unit of electricity} &= \text{Current reading} - \text{Previous reading} \\ &= 3697 - 3568 \\ &= 129 \end{aligned}$$

Now, Total amount to pay = 20 + 50 + 59 (By looking books direction)

$$\begin{aligned} &= \text{Rs.}4*20 + \text{Rs.}7.3*50 + \text{Rs.}8.6*59 \\ &= \text{Rs. } 80 + \text{Rs.}365 + \text{Rs.}507.4 \\ &= \text{Rs. } 952.4 \end{aligned}$$

For 10 minutes:

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?
- e. The current reading and previous reading of Gopal's house of electricity is given below. Find the total utilize unit and calculate to amount have to pay.

Current reading = 3680

Previous reading = 3458

4. Homework:

Solve the problem from 1 to 3 given on exercise 4.1 of page number 39.

Teaching Episode - 2

Subject : C. Mathematics

Topic : Household Arithmetic (Exercise: 4.1, household expenses for use of electricity)

Duration of lesson: 45 minutes

Class : IX

Teacher : Prabin Kumar Rayamajhee

School : Shree Panchakanya Secondary School

1. Specific Objective:

At the end of this class the students will be able to check their electricity bills of any institution and calculate the total amount have to pay.

2. Teaching Materials:

Daily used teaching materials, electricity bills

3. Teaching Learning Activities:

Problem: The current reading and previous reading of Geeta's house of electricity is given below. Find the total utilize unit and calculate to amount have to pay.

Current reading = 5518

Previous reading = 5356

For 10 minutes:

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 and the teacher shows electricity bills and explains.

For 20 minutes:

ii. Thinking of a Plan and Carrying out Plan:

In this section, the teacher commands the students to -

- a. What may current reading mean?
- b. What may previous reading mean?
- c. How can it be solved?
- d. How can you calculate the amount?

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

$$\begin{aligned} \text{Utilize unit of electricity} &= \text{Current reading} - \text{Previous reading} \\ &= 5518 - 5356 \\ &= 162 \end{aligned}$$

Now, Total amount to pay = 20 + 50 + 92 (By looking books direction)

$$\begin{aligned} &= \text{Rs.}4*20 + \text{Rs.}7.3*50 + \text{Rs.}8.6*92 \\ &= \text{Rs. } 80 + \text{Rs.}365 + \text{Rs.}791.2 \\ &= \text{Rs. } 1236.2 \end{aligned}$$

For 10 minutes:

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?
- e. The current reading and previous reading of Gopal's house of electricity is given below. Find the total utilize unit and calculate to amount have to pay.

Current reading = 3680

Previous reading = 3458

4. Homework:

Solve the problem from 4 to 6 given on exercise 4.1 of page number 39.

Teaching Episode - 3

Subject : C. Mathematics

Topic : Household Arithmetic (Exercise: 4.2, household expenses for use of water)

Duration of lesson: 45 minutes

Class : IX

Teacher : Prabin Kumar Rayamajhee

School : Shree Panchakanya Secondary School

1. Specific Objective:

At the end of this class the students will be able to check their water bills of any institution and calculate the total amount have to pay.

2. Teaching Materials:

Daily used teaching materials, water's bill of any institution.

3. Teaching Learning Activities:

Problem: The water bill of pradip's home is given below where the precious reading is 1340 and the current reading is 1372. Find the total amount to pay with 50% extra gutter charge.

For 10 minutes:

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.

For 20 minutes:

ii. Thinking of a Plan and Carrying out Plan:

Here, Current reading = 1372

Previous reading = 1340

$$\begin{aligned}\text{Utilize unit} &= 1372 - 1340 \\ &= 32\end{aligned}$$

Minimum charge =Rs.100

$$\begin{aligned}\text{Charge of remaining} &= \text{Rs}, 32 * 22 \\ &= \text{Rs}. 704\end{aligned}$$

$$\begin{aligned}\text{Total amount} &= \text{Rs}. 704 + \text{Rs}. 100 \\ &= \text{Rs}. 804\end{aligned}$$

$$\begin{aligned}\text{Charge for gutter} &= \text{Rs}. 804 * 50 / 100 \\ &= \text{Rs}. 402\end{aligned}$$

$$\begin{aligned}\text{So, the actual amount to pay} &= \text{Rs}. 804 + \text{Rs}. 402 \\ &= \text{Rs}, 1206\end{aligned}$$

For 10 minutes:

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:

Problem: The water bill of pradi's home is given below where the previous reading is 1340 and the current reading is 1450. Find the total amount to pay with 60% extra gutter charge.

4. Homework:

Solve the problem from 1 to 3 given on exercise 4.2

Teaching Episode - 4

Subject : C. Mathematics

Topic : Household Arithmetic (Exercise: 4.2, household expenses for use of water)

Duration of lesson: 45 minutes

Class : IX

Teacher : Prabin Kumar Rayamajhee

School : Shree Panchakanya Secondary School

1. Specific Objective:

At the end of this class the students will be able to check their water bills of any institution and calculate the total amount have to pay.

2. Teaching Materials:

Daily used teaching materials, water's bill of any institution.

3. Teaching Learning Activities:

Problem: The water bill of James home is given below where the precious reading is 1280 and the current reading is 1472. Find the total amount to pay with 50% extra gutter charge.

For 10 minutes:

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.

For 20 minutes:

ii. Thinking of a Plan and Carrying out Plan:

Here, Current reading = 1472

Previous reading = 1280

$$\begin{aligned}\text{Utilize unit} &= 1472 - 1280 \\ &= 192\end{aligned}$$

Minimum charge =Rs.100

$$\begin{aligned}\text{Charge of remaining} &= \text{Rs.}192 \times 22 \\ &= \text{Rs.}4224\end{aligned}$$

$$\begin{aligned}\text{Total amount} &= \text{Rs.}4224 + \text{Rs.}100 \\ &= \text{Rs.}4324\end{aligned}$$

$$\begin{aligned}\text{Charge for gutter} &= \text{Rs.}4324 \times 50/100 \\ &= \text{Rs.}2162\end{aligned}$$

$$\begin{aligned}\text{So, the actual amount to pay} &= \text{Rs.}2162 + \text{Rs.}4324 \\ &= \text{Rs.}6486\end{aligned}$$

For 10 minutes:

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:

Problem: The water bill of pradi's home is given below where the previous reading is 1301 and the current reading is 1478. Find the total amount to pay with 60% extra gutter charge.

4. Homework:

Solve the problem from 1 to 3 given on exercise 4.2

Teaching Episode - 5

Subject : C. Mathematics

Topic : Household Arithmetic (Exercise: 4.3, household expenses for use of telephone)

Duration of lesson: 45 minutes

Class : IX

Teacher : Prabin Kumar Rayamajhee

School : Shree Panchakanya Secondary School

1. Specific Objective:

At the last of this lesson students will be able to check their telephone bills of any institution and calculate the total amount have to pay.

2. Teaching Materials:

Daily used teaching materials, telephone bills of any house.

3. Teaching Learning Activities:

Problem: The current reading and previous reading of Seeta's house of telephone is given below. Find the total call and calculate to amount have to pay by looking books direction.

Current reading = 2276

Previous reading = 2050

For 10 minutes:

i. Understanding the Problem:

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

- What is telephone and water bills and how we calculate the total amount?
- Can we generalize the above knowledge here?

- What is problem given here?

For 20 minutes:

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.

Here, Current reading =2276

Previous reading =2050

Utilized call =2276-2050
=224

Amount of first 175 calls=Rs.200

Remaining call =224-175
=49

Amount of remaining call=Rs1*49
=Rs.49

Therefore, Total amount=Rs.200+Rs.49
=Rs.249

For 10 minutes:

Looking back: Problem: The current reading and previous reading of Hari's house of telephone is given below. Find the total call and calculate to amount have to pay by looking books direction.

Current reading = 2500

Previous reading = 2322

4. Homework:

Solve the problems 1 to 4 from your exercise 4.3 Of page number 45.

Teaching Episode – 6

Subject : C. Mathematics

Topic : Household Arithmetic (Exercise 4.4, Calculation of Amount of taxi meter)

Duration of lesson: 45 minutes

Class : IX

Teacher : Prabin Kumar Rayamajhee

School : Shree Panchakanya Secondary School

1. Specific Objective:

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

- Calculate the total amount of taxi while riding on taxi by themselves.

2. Teaching Materials:

Daily used teaching materials, bills of taxi meter.

3. Teaching Learning Activities:

Problem: Pemba travelled 5 Km from kalanki to simhadarbar. The minimum charge of taxi is Rs.14, then Rs.7.20 per 200 m. Calculate the total amount paid by Pemba.

For 10 minutes:

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 minimum charge mean?
- b. Can we generalize this problem with previous lesson?
- c. Do you understand all the words on the problem?
- d. What is given here?
- e. What is to find in the problem?

For 10 minutes:

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?

For 20 minutes:

iii. Carrying out Plan and Looking Back:

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

For solution

Minimum charge=Rs.14

Travelled distance= $5 \times 1000\text{m}$

=5000 m.

Cost of 200 m.=Rs,7.20

Cost of 1 m. =Rs.7.20/200

Cost of 5000 m. =Rs.7.20/200*5000

=Rs.180

4. Homework:

Solve the problems no 1 to 3 from your exercise 4.4 of page number 47.

Teaching Episode – 7

Subject : C. Mathematics

Topic : Household Arithmetic (Exercise 4.4, Calculation of Amount of taxi meter)

Duration of lesson: 45 minutes

Class : IX

Teacher : Prabin Kumar Rayamajhee

School : Shree Panchakanya Secondary School

1. Specific Objective:

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

- Calculate the total amount of taxi while riding on taxi by themselves.

2. Teaching Materials:

Daily used teaching materials, bills of taxi meter.

3. Teaching Learning Activities:

Problem: Pemba travelled 6 Km from kalanki to Thankot. The minimum charge of taxi is Rs.14, then Rs.7.20 per 200 m. Calculate the total amount paid by Pemba.

For 10 minutes:

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 minimum charge mean?
- b. Can we generalize this problem with previous lesson?
- c. Do you understand all the words on the problem?
- d. What is given here?
- e. What is to find in the problem?

For 10 minutes:

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?

For 20 minutes:

iii. Carrying out Plan and Looking Back:

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

For solution

Minimum charge=Rs.14

Travelled distance= $6 \times 1000\text{m}$

=6000 m.

Cost of 200 m.=Rs,7.20

Cost of 1 m. =Rs.7.20/200

Cost of 6000 m. =Rs.7.20/200*6000

=Rs.360

4. Homework:

Solve the problems no 4 to 6 from your exercise 4.4 of page number 47.

Teaching Episode – 8

Subject : C. Mathematics

Topic : Commission, Taxation and Bonus

Duration of lesson: 45 minutes

Class : IX

Teacher : Prabin Kumar Rayamajhee

School : Shree Panchakanya Secondary School

1. Specific Objective:

At the end of this class the students will be able to solve the problem related to commission.

2. Teaching Materials:

Daily used teaching materials.

3. Teaching Learning Activities:

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

For 10 minutes:

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.

For 20 minutes:

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,

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

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

$x = \text{Rs. } 3600$

For 10 minutes:

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?
- e. What will be the total sales in order to receive Rs.2000 at the rate of 8% as commission?

4. Homework:

Solve the questions number 1 to 4 from your exercise 3.1 of page number 22

Teaching Episode - 9

Subject : C. Mathematics

Topic : Ratio and Proportion (Exercise 9.1)

Duration of lesson: 45 minutes

Class : IX

Teacher : Prabin Kumar Rayamajhee

School : Shree Panchakanya Secondary School

1. Specific Objective:

At the end of this class the students will be able to solve problems based on ratio and proportion.

2. Teaching Materials:

Daily used teaching materials.

3. Teaching Learning Activities:

Problem:1) What is ratio and proportion? Illustrate with example.

Problem:2) If $\frac{a}{b} = \frac{3}{4}$, then find the value of $(4a+2b)/(4a+3b)$

For 10 minutes:

i. Understanding the Problem:

Start the lesson by asking the question about ratio and proportion 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 ratio mean?
- c. What does the proportion mean?

Then the teacher will explain like this, the comparison between two or more than two quantities of the same unit is called ratio and the equities of two ratio is called proportion.

For 10 minutes:

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.

For 10 minutes:

iii. Carrying out Plan:

In this section, 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 ideas i.e. the comparison between two or more than two quantities of the same unit is called ratio and the equality of the two ratio is proportion. For example: the ratio of 30 min. and 60 min. is $\frac{1}{2}$ and the two ratios $\frac{1}{2}$ and $\frac{4}{8}$ are in proportion.

For second problem,

Here, $\frac{a}{b} = \frac{3}{4}$, then $4a = 3b$ so,

$$= (4a+2b)/(4a+3b)$$

$$= (3b+2b)/(3b+3b)$$

$$= 5b/6b$$

$$= 5/6$$

For 10 minutes:

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.

If $a/b = 5/6$, then find the value of $(5a-2b)/(6a+2b)$

4. Homework:

Solve the question no. 1 to 5 from your exercise 9.1 of page number 90.

Appendix - 2

Mathematics Achievement Test in Pre-Test and Post-Test of the Questions

Class: IX

Subject: Mathematics

Full Mark: 20

Pass Mark: 8

Attempt all the Questions: $10 \times 2 = 20$

1. Convert the fraction into percentage $\frac{1}{3}$.
2. Convert the percentage into fraction 90%.
3. Find the utilized unit of electricity if the previous reading is 5678 and the current reading is 5764.
4. Find 3% discount of Rs. 1200.
5. If number of copy=5, Total cost= Rs. 250. Then find the cost of 1 copy,
6. Sita gains 24 marks out of 30 in an exam. What percentage is this?
7. If the cost of 5 T-shirts is Rs.500. find the cost of 15 such T-shirts.
8. A watch which was brought for Rs. 1000 was sold for Rs.800. What will be the loss in percent?
9. If $\$77 = \pounds 44$ and $\text{Rs.}1575 = \$21$. How many pounds (£) will be equal to Rs.4725?
10. Sangita bought 7kg 500 gram of orange for Rs.255. So how many oranges did she buy for Rs.306 ?

Appendix - 3

Item analysis of subjective questions of the test

S.N.→ Q.N↓	Upper 27%								Lower 27%								P% Value	D Value	Remark
	1	2	3	4	5	6	7	Total	1	2	3	4	5	6	7	Total			
1	1	1	1	1	1	1	1	7	1	1	1	0	0	1	1	5	85.71%	0.29	Reject
	1	1	1	1	1	1	1	7	1	1	1	0	0	1	1	5	85.71%	0.29	
	85.71%																0.29		
2	1	1	1	1	1	1	0	6	1	0	0	0	0	1	0	2	57.14%	0.57	Accept
	1	1	1	1	1	1	0	6	1	0	0	0	0	1	0	2	57.14%	0.57	
	57.14%																0.57		
3	1	1	1	1	1	1	0	6	1	1	0	0	1	1	0	4	71.43%	0.29	Accept
	1	1	1	1	1	1	0	6	1	1	0	0	1	1	0	4	71.43%	0.29	
	71.43%																0.29		
4	1	1	1	0	0	0	1	4	0	0	1	0	1	0	1	3	50%	0.14	Reject
	1	1	1	0	0	0	1	4	0	0	1	0	1	0	1	3	50%	0.14	
	50%																0.14		
5	0	1	1	1	1	1	1	6	1	0	0	0	1	0	0	2	57.14%	0.57	
	0	1	1	1	1	1	1	6	1	0	0	0	1	0	0	2	57.14%	0.57	
	0	1	1	1	1	0	1	5	0	0	0	1	0	0	0	1	42.86%	0.57	

	0	1	1	1	1	0	1	5	0	0	0	0	1	0	0	1	42.86%	0.57	
																	50%	0.57	Accept
6	1	1	0	1	1	0	1	5	0	1	1	0	0	0	0	2	50%	0.43	
	1	1	0	1	1	0	1	5	0	1	1	0	0	0	0	2	50%	0.43	
	1	1	0	1	1	0	1	5	0	1	1	0	0	0	0	2	50%	0.43	
	1	1	0	1	1	0	1	5	0	1	1	0	0	0	0	2	50%	0.43	
																	50%	0.43	Accept
7	1	1	1	0	0	0	1	4	1	1	1	1	1	0	0	5	64.29%	-0.14	
	1	1	1	0	0	0	1	4	1	1	1	1	1	0	0	5	64.29%	-0.14	
	1	1	1	0	0	0	1	4	1	1	1	1	1	0	0	5	64.29%	-0.14	
	1	1	1	0	0	0	1	4	1	1	1	1	1	0	0	5	64.29%	-0.14	
																	64.29%	-0.14	Reject
8	0	1	1	1	1	1	1	6	0	0	0	1	0	0	1	2	57.14%	0.57	
	0	1	1	0	1	1	1	5	0	0	0	1	0	0	1	2	50%	0.43	
	0	1	1	0	1	1	0	4	0	0	0	0	0	0	1	1	71.43%	0.43	
	0	1	1	0	1	0	0	3	0	0	0	0	0	0	1	1	28.57%	0.29	
																	51.79%	0.43	Accept
9	1	0	1	1	1	1	0	5	0	0	0	0	0	1	0	1	42.86%	0.57	
	1	0	1	1	1	1	0	5	0	0	0	0	0	1	0	1	42.86%	0.57	
	1	0	1	1	1	1	0	5	0	0	0	0	0	1	0	1	42.86%	0.57	

	1	0	1	1	1	1	0	5	0	0	0	0	0	0	1	0	1	42.86%	0.57	
																	42.86%	0.57	Accept	
10	1	0	0	1	0	1	0	3	0	0	0	1	0	0	0	0	1	28.57%	0.29	
	1	0	0	1	0	1	0	3	0	0	0	1	0	0	0	0	1	28.57%	0.29	
	1	0	0	1	0	1	0	3	0	0	0	1	0	0	0	0	1	28.57%	0.29	
	1	0	0	1	0	1	0	3	0	0	0	1	0	0	0	0	1	28.57%	0.29	
																	28.57%	0.29	Accept	
Total	24	24	24	23	22	19	18		12	12	12	11	11	10	8					

Appendix - 4

Reliability of the test

S.N.	Scores on odd items (X)	Scores on even items (Y)	X ²	Y ²	XY
1	24	16	576	256	384
2	20	14	400	196	280
3	28	28	784	784	784
4	36	24	1296	576	864
5	24	16	576	256	384
N = 15	ΣX = 132	ΣY = 98	ΣX ² = 3632	ΣY ² = 2068	ΣXY = 2696

$$\begin{aligned} \text{Correlation Coefficient } (r_{xy}) &= \frac{N \sum XY - \sum X \cdot \sum Y}{\sqrt{N \sum X^2 - (\sum X)^2} \sqrt{N \sum Y^2 - (\sum Y)^2}} \\ &= \frac{5 \times 2696 - 132 \times 98}{\sqrt{5 \times 3632 - (132)^2} \sqrt{5 \times 2068 - (98)^2}} \\ &= 0.74 \end{aligned}$$

$$\text{Reliability Coefficient } (r) = \frac{2 r_{xy}}{1 + r_{xy}} = \frac{2 \times 0.74}{1 + 0.74} = 0.85$$

Appendix - 5
Score of Pre-test

S.N.	Score of Students in Experimental Group	Score of Students in Control Group
1	16	13
2	7	11
3	11	6
4	8	7
5	7	12
6	4	5
7	4	7
8	9	5
9	7	5
10	5	2
11	5	3
12	5	3
13	5	3
14	6	5
15	3	2
16	2	3
17	2	3
18	3	3
19	2	2
20	3	5
21	2	1
22	2	3
23	2	2
24	3	3
25	2	3
26	2	1
27	5	5
28	4	3
29	3	1
30	4	3
31	2	1
32	4	2
33	4	1
34	5	2
35	6	3
36	3	3
37	2	1
38	3	4
39	4	5
40		4
41		3
42		4
43		4
	$N_1 = 39, \bar{x}_1 = 4.51, s_1^2 = 8.20,$ $s_1 = 2.86$	$N_2 = 43, \bar{x}_2 = 4.09, s_2^2 = 10.09,$ $s_2 = 3.18$

Appendix - 6
Score of Post-test

S.N.	Score of Students in Experimental Group	Score of Students in Control Group
1	19	16
2	17	15
3	19	13
4	17	10
5	12	14
6	14	11
7	17	9
8	12	11
9	15	13
10	16	9
11	17	11
12	10	11
13	15	9
14	8	7
15	10	11
16	10	7
17	7	9
18	8	8
19	13	9
20	7	10
21	7	2
22	10	6
23	11	5
24	11	6
25	11	10
26	10	8
27	14	11
28	10	7
29	13	7
30	15	9
31	7	6
32	13	6
33	15	6
34	15	6
35	12	7
36	9	7
37	10	4
38	8	7
39	6	9
40		5
41		7
42		6
43		7
	$N_1 = 39, \bar{x}_1 = 12.05, s_1^2 = 12.99,$ $s_1 = 3.61$	$N_2 = 43, \bar{x}_2 = 8.53, s_2^2 = 8.73,$ $s_2 = 2.95$

Appendix - 7

Statistical Formula Used in Data Collection and Analysis Procedure

S.N.	Subject	Notation	Formula
1	Pooled Variance	S_p^2	$\frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}$
2	t - distribution	T	$\frac{(\bar{X}_1 - \bar{X}_2) - (\mu_1 - \mu_2)}{S_p \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$
3	F-distribution	F	$\frac{S_1^2}{S_2^2}$
4	Degree of freedom	d.f.	$n_1 + n_2 - 2$
5	Pearsons's Correlation Coefficient	r_{xy}	$\frac{N \sum XY - \sum X \cdot \sum Y}{\sqrt{N \sum X^2 - (\sum X)^2} \sqrt{N \sum Y^2 - (\sum Y)^2}}$
6	Reliability Coefficient	R	$\frac{2 r_{xy}}{1 + r_{xy}}$
7	Difficulty Level of Item	P%	$\left(\frac{R_u + R_l}{N} \times 100 \right) \%$
	Discrimination Index of Item	D	$\left(\frac{R_u - R_l}{N} \right)$
			Where R_u and R_l are the number of correct response given by upper 27% and lower 27% students respectively, N is the total number of lower 27% students plus total number of upper 27% students.

Appendix – 8

Statements of the Interview

Namaskar, I am Prabin Kumar Rayamajhee. I am the student of the thesis year of M.Ed. I am searching the effectiveness of the problem solving method at secondary level through this thesis. I hope to active participation of you all.

1. Did you enjoyed my class? Did you get some differences in teaching strategies in comparison to previous?
2. Which aspect/activity of my teaching you like most? Why?
3. I use to use lecture method but now this is problem solving method. Which one do you choose or enjoyed and why?
4. What types of teaching does your teacher use in your classroom while teaching?
5. Are there any negative aspects of the problem solving method?
6. What should be considered to make this problem solving method better?
7. What are the differences between problem solving method and traditional method?
8. Can we use problem solving method in every subject?

Thank you for your valuable time and help.