

**EFFECTIVENESS OF PROBLEM BASED LEARNING STRATEGY IN
TEACHING MATHEMATICS**

**A
THESIS
BY
PRAKASH MALLA**

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

**SUBMITTED
TO
DEPARTMENT OF MATHEMATICS EDUCATION
CENTRAL DEPARTMENT OF EDUCATION
UNIVERSITY CAMPUS
TRIBHUVAN UNIVERSITY
KIRTIPUR, NEPAL**

2020



त्रिभुवन विश्वविद्यालय
शिक्षा शास्त्र केन्द्रीय विभाग
गणित शिक्षा विभाग

विश्वविद्यालय क्याम्पस
कीर्तिपुर, काठमाडौं, नेपाल

UNIVERSITY CAMPUS
Kirtipur, Kathmandu, Nepal

TRIBHUVAN UNIVERSITY
CENTRAL DEPARTMENT OF EDUCATION
DEPARTMENT OF MATHEMATICS EDUCATION

पत्र संख्या:-
Ref.

मिति:
Date:

LETTER OF CERTIFICATE

This is to certify that Mr Prakash Malla a student of academic year 2070/1 with Campus Roll NO. 616, Thesis No. 1324, Exam Roll NO. 280475 (2073) and TU Regd. No. 9-2-50-976-2009 has completed this thesis for the period prescribed by the rules and regulations of Tribhuvan University, Nepal. This thesis entitled **“Effectiveness of Problem Based Learning Strategy in Teaching Mathematics”** has been prepared based on the results of his investigation. I hereby recommend and forward that his thesis be submitted for the evaluation as the partial requirements to award the degree of Master of Education.

.....

Prof. Dr. Bed Raj Acharya

(Head)

Date: 14 August, 2020

30 Sharwan, 2077



त्रिभुवन विश्वविद्यालय
शिक्षा शास्त्र केन्द्रीय विभाग

गणित शिक्षा विभाग

TRIBHUVAN UNIVERSITY

CENTRAL DEPARTMENT OF EDUCATION

DEPARTMENT OF MATHEMATICS EDUCATION

विश्वविद्यालय क्याम्पस
कीर्तिपुर, काठमाडौं, नेपाल

UNIVERSITY CAMPUS
Kirtipur, Kathmandu, Nepal

पत्र संख्या:-
Ref.

मिति:
Date:

LETTER OF APPROVAL

This thesis entitled “**Effectiveness of Problem Based Learning Strategy in Teaching Mathematics**” submitted by Mr Prakash Malla in partial fulfilment of the requirements for the Master's Degree in Education has been approved.

Viva Voce Committee

Signature

Prof. Dr. Bed Raj Acharya

.....

(Chairman)

Prof. Uma Nath Pandey

.....

(External)

Prof. Dr. Eka Ratna Acharya

.....

(Member)

Date: 14 August, 2020

30 Sharwan 2077



त्रिभुवन विश्वविद्यालय
शिक्षा शास्त्र केन्द्रीय विभाग

गणित शिक्षा विभाग

TRIBHUVAN UNIVERSITY

CENTRAL DEPARTMENT OF EDUCATION

DEPARTMENT OF MATHEMATICS EDUCATION

विश्वविद्यालय क्याम्पस
कीर्तिपुर, काठमाडौं, नेपाल

UNIVERSITY CAMPUS
Kirtipur, Kathmandu, Nepal

पत्र संख्या:-
Ref.

मिति:
Date:

RECOMMENDATION FOR ACCEPTANCE

This is to certify that Mr Prakash Malla has completed his M. Ed. thesis entitled
“Effectiveness of Problem Based Learning Strategy in Teaching Mathematics”
under my supervision during the period prescribed the rules and regulations of
Tribhuvan University, Kirtipur, Kathmandu, Nepal. I recommend and forward his
thesis to the Department of Mathematics Education to organize final viva-voce.

.....
(Prof. Dr. Eka Ratna Acharya)

Date: 14 August, 2020

Supervisor

30 Sharwan 2077

DECLARATION

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

.....

Prakash Malla

Date: 14 August, 2020

30 Sharwan, 2077

©2020

Copyright by Prakash Malla

This document is copyright material. Under the law, no parts of this document may be reproduced without the expressed permission of the researcher.

Defense Date: 14 August, 2020

All Right Reserved

DEDICATION

To My Parents:

Mr. Mahendra Malla and Mrs. Ishwora Malla

ACKNOWLEDGEMENTS

I would like to express my very great appreciation to my research supervisor Prof. Dr. Eka Ratna Acharya, for his approachable, practical and valuable suggestions during the planning and development of the research work. Without his professional supervision and time given to understand my ideas, it would not be possible to complete this research work.

My sincere goes to Prof. Dr. Bed Raj Acharya, Head of Department of Mathematics Education, for his advice and high-end feedback on my research work.

Furthermore, I would like to thank Prof. Uma Nath Pandey and Mr. Krishna Prasad Bhatt for them invaluable suggestions to form this research more academic.

I would like to thank students of the experimental and control group for their active participation, and the teachers of mathematics and principals of the schools where I completed my research.

Finally, I wish to thank my parents for their support and encouragement up to the minute.

.....

Prakash Malla

Date: 14 August, 2020

30 Sharwan, 2077

ABSTRACT

The title of this research was “**Effectiveness of Problem Based Learning Strategy in Teaching Mathematics**”. The primary purpose of this study was to compare the mathematics achievement and to identify the effectiveness of problem based learning strategy in teaching mathematics. Two private schools were selected in Kathmandu district and pre-test and post-test nonequivalent control group design was used to conduct this study. The study was based on mixed design research. Experimental group taught by using Krall’s problem based learning strategy and control group was taught by using conventional problem solving strategy for same topic. The internal consistency of each test was ensured by calculating Cronbach’s Alpha model with SPSS 21.0 setting 0.05 level of significance.

Achievement tests and teaching episodes were the main tools for the study and mean, standard deviation and t-test (at 0.05 level of significance) were used as statistical tools and analyze qualitative data by students’ motivation and participation in the activities. After one month of regular treatment to the experimental group, achievement of students from both groups was recorded in terms of post-test. From the result, the study has succinctly shown that there was a significant difference in students’ achievement of experimental and control groups in post-test. More importantly, the result indicated that problem based learning strategy is effective than the conventional problem solving strategy.

TABLE OF CONTENTS

	Page
<i>Letter of Certificate</i>	<i>i</i>
<i>Letter of Approval</i>	<i>ii</i>
<i>Recommendation for Acceptance</i>	<i>iii</i>
<i>Declaration</i>	<i>iv</i>
<i>Copy rights</i>	<i>v</i>
<i>Dedication</i>	<i>vi</i>
<i>Acknowledgements</i>	<i>vii</i>
<i>Abstract</i>	<i>viii</i>
<i>Table of Contents</i>	<i>ix</i>
<i>List of Tables</i>	<i>xii</i>
<i>List of Figure</i>	<i>xiii</i>
<i>Acronyms</i>	<i>xiv</i>
Chapters	
I: INTRODUCTION	1-8
Background of the Study	1
Statement of the Problem	4
Objectives of the Study	5
Justification of the Study	6
Hypothesis of the Study	6
Delimitations of the Study	7
Definition of the key terms	7
II: REVIEW OF RELATED LITERATURE	9-19
Empirical Literature	9

Research Gap	13
Theoretical Framework of the Study	13
Conceptual Framework of the Study	18
III: RESEARCH METHODOLOGY	20-32
Research design	20
Phase of the experiment	21
Population of the Study	22
Sample of the Study	22
Data Collection Tolls	22
Validation of the Tools	24
Calculation of Relativity	25
Dependent and independent Variables	25
Control mechanism for extraneous Variables	25
Control of Variables (Extraneous / Confounding)	25
Scoring of the Data	26
Experimental Validity Threats	27
Data Collection Procedure	30
Data Analysis and Interpretation Procedure	30
Ethical Consideration	31
IV: ANALYSIS AND INTERPRETATION OF DATA	33-43
Comparison of Mathematics Achievement Score of Control and Experimental Group in Pre-test Result	33
Comparison of Mathematics Achievement Score of Control and Experimental Group in Post-test Result	34
Qualitative Data Analysis	36

V: SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS	44-46
Summary and Findings	44
Conclusion of the Study	45
The Implication of the Research	46
Recommendation for Further Research	47

References

Appendices

LIST OF TABLES

Table I: Comparison between conventional and problem based learning strategy	17
Table II: Design of the study	20
Table III: Results of independent t-test on the pre-test	33
Table IV: Results of the independent t-test on post-test	35

LIST OF FIGURES

Figure I: Stage of problem based learning using Krall's framework	14
Figure II: Conceptual frame work	18
Figure III: Comparison of Students' Achievement in pretest	34
Figure IV: Comparison of Students' Achievement in posttest	35

ACRONYMS

CPSS	: Conventional Problem Solving Strategy
KPBLs	: Krall's Problem Based Learning Strategy
PBL	: Problem Based Learning
NASA	: National Assessment of Students Achievement
NCTM	: National Council of Teachers of Mathematics
SD	: Standard Deviation
SPSS	: Statistical Package for Social Science

CHAPTER I

INTRODUCTION

This is the research entitled “Effectiveness of Problem Based Learning Strategy in Teaching Mathematics”. This is the first chapter, which is consist of general background, statement of the problem, objective of the study, justification of the study, hypothesis of the study, delimitation of the study and definition of key terms.

Background of the Study

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

Problem based Learning (PBL), is a new pedagogical and realistic approach of learning stemmed from constructivism approach to education that regards learning as an active process in which learner constructs the meaning of subject matter rather passively received the finished product of knowledge based on his/her present and past state of knowledge and experiences or in other word learners are supposed as an independent participants and critical inquirers. In PBL, the problem means an open ended situations and future facing anticipated problems that learner needs to know for

his/her succession in the present world. Problem based means the curriculum is delivered as series of stimulation of realistic problem (Gordon, Rogers, Comfort, Gavula, & Mcgee, 2001). A more comprehensive interpretation of PBL is avowed by Hoffman and Ritchie (1997,97): “problem based learning is a student-centered pedagogical strategy that poses significant, contextualized, real-world, ill-structured situations while providing resources, guidance, instruction, and opportunities for reflection to learners as they develop content knowledge and problem-solving skills”. At the commencement of PBL students are engaged with solving problems that may be future professional related challenges or daily life sustaining related complex problems and that entails students to work on the small and interactive peer groups for the purpose of finding proper, divergent but unique solutions of the posed problems. Insofar as multifaceted problems (those that mimic real-life problems and allow a variety of ways to reach a solution) can also be used in the classroom to reveal student misconceptions that traditional tests miss (MacMath, Wallace, & Chi, 2009) and their observations of Ms. Perry’s class reveal that there is value in having students demonstrate they know when to use specific procedures by working through problems.

So, far as my view is concerned, Problem Based Learning (PBL), is an active and student centered educational strategy for learning stemmed from constructivism approach of learning that helps students build the abstract reasoning skills, versatile communication skills, problem solving skills, higher order thinking skills and deep understanding skills that are mandatory and necessary for their successful performance in the intended and present work place. The basic principles of PBL are; students are given responsibility for their learning and assessing and reassessing it that shows learning as in the decentralized mode and contextual as well as authentic also;

collaborative, self- directed and cooperative learning should be emphasized in order to expose learners to alternative viewpoints; assessment should be used as an authentic and interwoven with teaching; contingent and constructed as a focus of knowledge; students are motivated based on expectancy theory, social theories, need theories, and cooperative theories of learning.

Problem based learning does not have a long history in terms of its systematic incorporation into formal curricula, it was pioneered by Howard Barrows and his colleagues in late 1960s at medical school program at McMaster University in Hamilton, Ontario, Canada but historically, Western Research Academy had a rudimentary model of PBL during 1950s. Due to the positive aspects of the PBL, it was adopted in other medical schools and became as accepted instructional approach across USA and Europe, during the 1980s and 1990s. And, the amid of the 1990s it had been frequently integrated into the beyond of Medical route subjects such as the University of Delaware used it in the chemistry, geology, mathematics, social science subjects, and other post education domain subjects; and the University of Hong Kong has used successfully it in teacher education courses.

In problem-based learning, the traditional teacher and student roles change. The students assume increasing responsibility for their learning, giving them more motivation and more feelings of accomplishment, setting the pattern for them to become successful life-long learners. A learning method based on the principle of using problems as a starting point for the acquisition and integration of new knowledge (Barrows 1982).

For searching solution of problems, Krall's problem based learning strategy is a new and scientific strategy then conventional problem solving strategy in teaching mathematics. In teaching mathematics problem solving is important to both teacher

and students for better understanding. Krall's (2012) developed a five problem based learning cycle as following steps.

Posing the problem: Students are presented with a problem which is complex ill-structured concerned with real world phenomena. Such problems engaged the students as an independent critical inquire.

Work on the problem: Students work on the small and interactive group for sharing and organizing their ideas including the past and present current state of knowledge and experience related to given problem.

Intervention as a question arises: Students learn by doing something new whereas the tutor provides the series of arising conundrum in the cordial ways so that students employ the rules to find the proper solutions.

Students apply the instruction: Students share their solutions. Here instructor position again themselves to watch over the students work and how they are using and misusing knowledge they are trying to achieve and finally, tutor provides feedback.

A solution reached: Here students reached the solution, that expected as a new and different and along with the phase new problem is given problem based learning takes at least three scenarios per unit at once whole learning is focus than final product.

For the context of Nepal there are many ways to start problem based learning but it worth considering some of the useful models, I want to suggest five steps of PBL cycle in mathematics provide by Geoff Krall's (2012).

Statement of the Problem

Mathematics is one of the important disciplines with broader application all over the world. Owing to dearth use of materials, strategy in mathematics students still lack procedural knowledge in problem solving and student creativity has reached very low label. Consequently, there are many reasons such as mathematics focus on

product rather than process. Teaching emphasis on fixed knowledge and text to teach based phenomena which enforce to focus on rote learning than understanding. In Nepal, the teaching and learning situation of mathematics is not satisfactory and higher numbers of students are being failed in mathematics. According NASA report 2011 AD the average achievement of students in mathematics was 43 percent. Similarly, (NASA) report 2013 AD presented 35 percent average achievement of students in mathematics which shows the poor performance of students' continuously. There are not sufficient teaching materials and appropriate teaching methods. Students have the habit of reading mathematics like other subjects and do not practice mathematics problem sufficiently.

Krall's problem based learning strategy is one of the appropriate strategies in mathematics that many teachers do not use. Therefore the main concern of this study is to comparison of the learning effectiveness of PBL and conventional method of teaching mathematics in solving mathematics problem addressing the following research questions.

- In what ways Krall's problem based learning strategy differs from conventional problem solving strategy in mathematics?
- To what extent Krall's problem based learning strategy is effective?

Objective of the study

The primary objective of the study was to identify the effectiveness of problem based learning strategy in teaching mathematics. This objective is specially stated in the following way:

- To compare the students' achievement scores in mathematics taught by Krall's problem based learning strategy and conventional strategy.

- To explore the effectiveness of Krall's problem based learning strategy in teaching mathematics.

Justification of the Study

This researcher would help to identify the effectiveness of Krall's problem based learning strategy in mathematics achievement of school level. It would help for the teachers, mathematics educators, curriculum planners and researchers to follow problem based skills and methods. It would be beneficial to the concerned person and agencies to choose the appropriate technique of teaching and improve their teaching Mathematics strategy. The most significant contribution of this study would be the effectiveness of problem-based learning strategy in teaching mathematics. This study would be significant as follows:

- To teach the particular topics of mathematics more effectively by using Krall's problem based learning strategy.
- This study is conducted to explore the effectiveness of Krall's problem based learning strategy in teaching mathematics.
- To improve the achievement of students in mathematics.
- To apply the Krall's problem based learning strategy in wider field of mathematics.

Hypothesis of the Study

Hypothesis helps the researcher to find out the fact in scientific way and testable form. So researcher has set the following hypothesis.

(a) Research Hypothesis

Students who were exposed to the Krall's problem based learning strategy achieve better score than those who were exposed to conventional problem solving strategy.

(b) Statistical Hypothesis

Null Hypothesis $H_0: \mu_1 = \mu_2$

Alternative Hypothesis $H_1: \mu_1 \neq \mu_2$

Where, μ_1 and μ_2 was mean achievement score of the students taught by Krall's problem based learning strategy and conventional problem solving strategy respectively.

Delimitation of the Study

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

- This was experimental research conducted at grade VIII regarding teaching arithmetic.
- This study was conducted on two groups of students, namely control group and experimental group, taken from two private schools of Kathmandu district.
- This study was concerned with only effectiveness of Krall's problem-based learning strategy in teaching mathematics at grade VIII.
- Achievement test, observation checklist, interview, motivation check list and episodes were the tools for data collection.
- The analysis of the data followed quantitative as well as qualitative.

Definition of key terms

- **Effectiveness:** In this study effectiveness is defined in terms of achievement of test, motivation participation, regularity of students in the class room teaching.
- **Control group:** - The group of students who were taught through traditional method of teaching.

- **Conventional strategy:** it is the teaching strategy teacher use lecture method in most of time.
- **Achievement:** The achievement on this study was defined in term of score obtained by the learner in mathematics.
- **Krall's problem-based learning strategy:** A problem based learning strategy developed by Geoff Krall's with five cycle models (2012).

CHAPTER II

REVIEW OF RELATED LITERATURE

This chapter conveys the review of relevant literature, which is divided into three sections. The first section presents the review of empirical literature, the second section includes the review of theoretical literature and final section contains the conceptual framework.

Empirical Literature

This part of review includes the data based findings of past researches related to the present study. While including such findings, one has to cite the author and year his/her research title including major objective/purpose, area of study, and methods; and significant results of the research. Any results from case study, surveys, Master's, MPhil, PhD theses, faculty research, NGOs and INGOs studies can be included in this section.

In this research, the main focus is on effectiveness of Krall's problem based learning strategy in mathematics. These aspects are briefly reviewed based on papers concern. Problem based learning was the basic mathematical activity. Since mathematics is regarded as the vital subject in school level education and higher level education also, problem based learning is seen as necessary for meaningful mathematics learning in Nepal in order to reach world level competitions by mounting the students' national level of achievement in mathematics from K to University level. There are some challenges for implementation of PBL in mathematics in Nepal such as it demands huge amount of direct as well as indirect social and individual costs, comprehensive planning regarding curriculum development and its practices, well managed administration, materials and well experienced tutor groups and like so that it should be gradually penetrated into the math curriculum as a few portion of content.

Most mathematics educators believed that problem based learning is an important instructional activity. Mathematical activity such as generalization, abstraction, theory building and concept formation are based on problem based learning. When an individual understands a principle has an opportunity to practice, s/he was able to employ and transfer knowledge of the principle in a variety of situation (Herreid, 2003).

Despite the above mentioned vital points, the related empirical literature is reviewed as below:

Mushlihuiddin, et. al. (2018), conducted a study entitled “The effectiveness of problem based learning on students’ problem solving ability in vector analysis course”. This study explored the effect of problem-based learning on students’ achievement in vector analysis in Medan Indonesia. The study was conducted on experimental design. This research was quasi-experiment research. The data analysis techniques performed from the test stage of data description, a prerequisite test the normally test and hypothesis test using the ANCOVA test and gain test. The study concluded that achievement of students can be improved in vector analysis course by teaching them using problem based learning strategy.

Bhatta (2016), conducted an experimental research on "Effectiveness of problem solving in learning mathematics at secondary level" with the aim to analyze the effectiveness of problem solving method. Also compared students’ achievement taught by using problem-solving method and by using traditional teaching method in grade IX. Two government schools were selected as convenience of researcher and pre-test and post -test nonequivalent group design was used to conduct this study. Achievement tests and teaching modules were the main tools for the study and data was analyzed by descriptive and inferential statistical tools. After analyzed the

obtained data, it was concluded that boys and girls were similar in learning mathematics and students had got better achievement by using problem solving method than that of the traditional method. Also concluded that problem solving method is effective than the traditional method in teaching mathematics.

Poudel (2015), studied on “Effectiveness of problem solving method in teaching mathematics in secondary level of grade IX” to explore the effectiveness of problem solving method in teaching mathematics in secondary level. This study was quasi experimental related to teaching strategies on mathematics education. Two boarding schools were selected as experimental and control group. Schools were selected on the basis of convenience of researcher. The study was pre-test and post-test nonequivalent group design to conduct the study. Achievement test and teaching modules were the main tools for the study and mean, standard deviation, variance and t- test were used as a statistical tool for analyzing the data. After analyzing the data it was concluded that problem solving method is effective in comparison to the traditional method of teaching in trigonometry of secondary mathematics curriculum.

Ajai,et.al (2013),carried out the research work on “Comparison of the learning effectiveness of problem based learning and conventional method of the teaching algebra.” The objective of this study was to find the PBL approach on senior secondary school students’ achievement in algebra. The design of the study was quasi-experimental pre-test, post-test and control group. Students’ algebra achievement test was the main tools for the study and data analysis by (ANCOVA) at 0.5 level of significance. The findings of the study showed that students taught using PBL achieved significantly higher in the post test than those taught algebra using conventional method.

The study carried out Olufemi (2012), entitled “Investigating the effectiveness of problem based learning in the further mathematics classroom”. The objective of the study was effect of PBL approach on students’ achievement in the further mathematics classroom. Four research question and four research hypothesis were raised as the tool for the study to collect the data. The study lasted thirteen week and data collected were analyzed using mean, standard deviation, independent sample t-test statistics, and analysis of variance. The study concluded that the PBL should be adopted as alternative instructional strategy to the traditional method in enhancing meaningful learning in the further mathematics.

Ali, et. al. (2010), conducted a study entitled on “Effect of using problem solving method in teaching mathematics on achievement of mathematics students”. This was quasi-experimental study conducted in Pakistan. The major purpose of the study was to investing the effect of using problem solving method on students’ achievement in teaching mathematics. Pre-test and post–test design was used in this study. Result was analyzed using mean, standard deviation and t-test. From the finding it was observed that the use of problem solving method enhanced the achievement of the students in mathematics.

Hung (2009) developed the 3C3R model in order to develop curriculum for PBL that model has two classes of components: core components and processing components. The core components-content, context, and connection-are primarily concerned with the issues of appropriateness and sufficiency of content knowledge, knowledge contextualization, and knowledge integration. The processing components-researching, reasoning, and reflecting-deal with students’ acquisition of content knowledge and the development of problem-solving skills and self-directed learning skills.

Slinder (2002), carried out the research work “The effectiveness of problem based learning in the high school science classroom” with the aim to compare the achievement levels of students taught by experimental problem based approach to the achievement of students taught by traditional approach. These students’ pre and post assessment scores were than compared to sixteen students in a different class where direct instruction technologies were used. The conclusion of this study found that PBL is an effective strategy to use in the classroom, especially regarding student engagement.

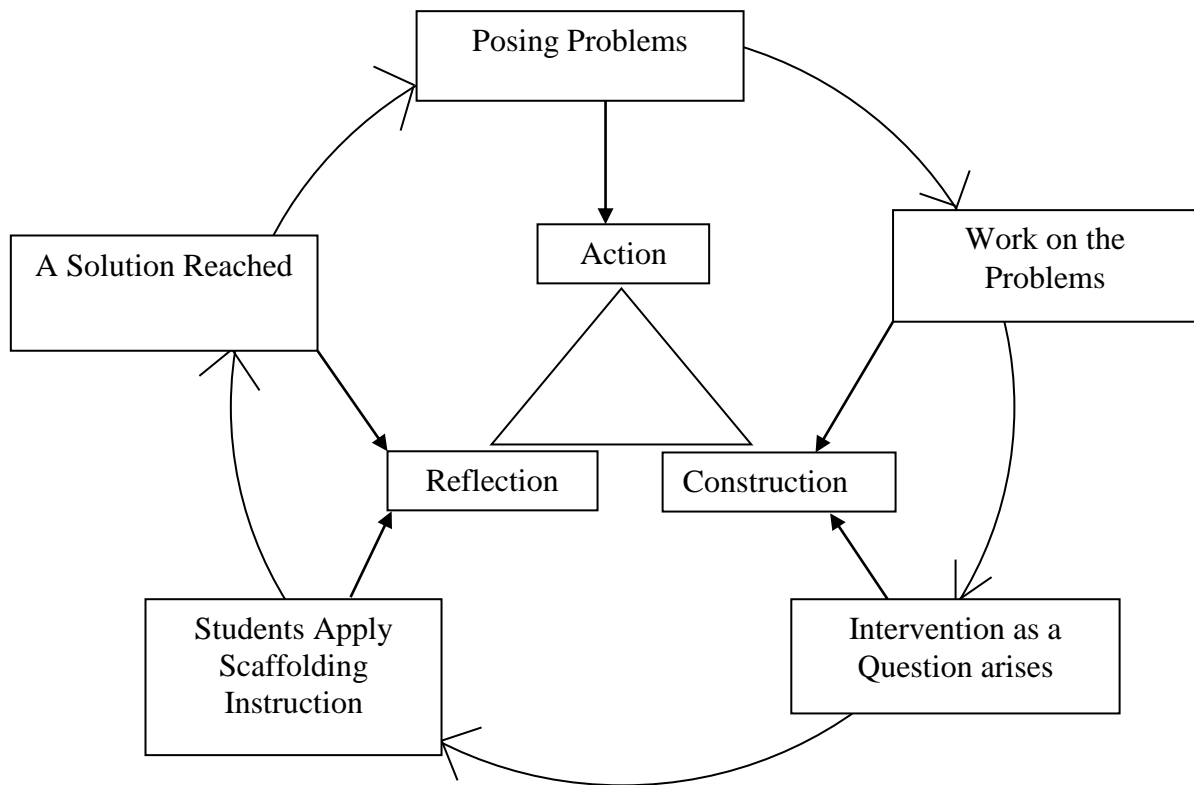
Research Gap

From, the above review of the related literature, it seems clear that mathematics education studies could not give a certain solution to overcome all the difficulties of learning and teaching arithmetic. Many of the work have been considered to address difficulties in teaching while others focusing on improving students’ achievement. However on few numbers of researchers that emphasis uses of problem based learning strategy on mathematics. There is still gap that how use of Krall;s problem based learning strategy helps to increase their performance in achievement test.

Theoretical Framework of the Study

Five steps of problem based learning cycle developed by Geoff Krall’s in 2012. In these steps focus is mainly on "word problems" of the type often found in K-12 or undergraduate math textbooks and exams, but there are also general principles that are more widely applicable.

.



Source: Geoff Krall(2012)

Figure I: Stage of problem based learning using Krall's (2012) frame work

Five steps of PBL in mathematics learning are as follow:

Posing problem:

In this phase, students are presented with a problem which is complex and ill-structured concerned with real-world phenomena. Such problems engaged the students as an independent critical inquire. Regarding it, Barnett has argued for three level of critically, which are as follows:

Critical thinking: Cognitive acts carried out the students come under it. For the development of this critically task based problems that makes students able to both i.e. development individual autonomy are necessary.

Critical thought: It is wider than individual thought as it is collaborative, contains social phenomena, and takes place within the discipline of the study. Moral problems that demand apprenticeship learning are believed fruitful.

Critique: This is third one level in which criticism about the discipline itself takes a stance towards knowledge. To developed the critically, the complexity of the discipline related problems are encouraged (Savin-Bared and Major, 2004).

In this step, mathematics teachers should work as good facilitator including knows and need to know aspects of problem. Similarly, he/she is to draw question from expected need to desired need to know through some potential next steps that the teacher suggest to the students are:

- Draw a diagram and pie charts using technology;
- Try some numeral values;
- Find the number that doesn't work;
- Break smaller cases;
- Do some online research;
- Write an equation or mathematical expressions, if necessary;
- Draw a possible graph that visualized the way of solution;

It should be consider that students won't have any ownership with knows need to knows and possible next steps.

Work on the problems

In this phase, students work on small and interactive group for sharing and organizing their ideas including the past and present current state of knowledge and experience related to the given problem and try to define the problem concisely and in the understanding ways. Here students have at least one actionable steps to have ownership. Similarly the facilitator should construe the student's ownership as in the critical understanding and clarify questions maintaining good mathematical thinking environment.

Intervention as a question arises

Assuming that the teacher posed a good problem/question rousing students naturally arise in the classroom, learning is actually taking place in this struggle phase as it is supposed that to learn something learner must interact frankly with it and ruminate towards the nature of given conundrum i.e. why students must be cognitively engaged in the given task. Here, students engaged in different types of facilities i.e. leading recording, discussing, world, complexity in the learning, developing and revising schedules, making real presentation, holding conferences, collaborative and co-operative learning. Students learn by doing something new whereas the tutor provides the series of arising conundrum in the cordial ways so that the students employ the rules to find the proper solutions. Some special tasks in this phase are;

- Students share out their work and their peers offer next steps.
- Students exchange work with other groups to solution strategies.
- Some kind of manipulative activity.
- Math visualized software.
- The action learning team.
- Student Conflate 'Hint cards'.

Students apply scaffolding instruction

Here students are supposed to apply the instruction and teacher suggests the students to refine works analyzing each other works and helps them for concluding remarks. Students share their solutions. Here instructor position again themselves to watch over students work and how they are using and misusing knowledge they are trying to achieve and finally, tutor provides feedback in this phase which is very informative to all the students.

A solution reached

Here students reached the solutions, that expected as a new and different and along with the phase new problem is given problem based learning takes at least three scenarios per unit at once whole learning process is a focus than final product.

There are many researches carried out related to effectiveness of problem solving methods but in the context of Nepal there were not found any research carried out being specific in effectiveness of problem based learning strategy in teaching mathematics. So it is my matter of interest to carry out research study in it. It would be useful to develop framework to think about the processes involved in mathematics problem solving.

Table I: Comparison between conventional and problem based learning strategy

Problem based learning strategy	Conventional Problem-solving strategy
Origination of knowledge Open-ended and situation.	Organization of knowledge Step by step solutions of given or restricted problems based on lecture notes.
Focus on knowledge Contingent and constructed.	Focus on knowledge Largely proportional ignoring practical aspects.
Role of students Active participants and independent critical inquires who own their own learning experiences.	Role of Students Bounded problem solver based on fixed rule provided by the lecturer.
Role of Tutor Enabler of opportunities for learning.	Role of Tutor Judge of right knowledge and solutions of the problem.
Type of Activity Development of strategies to facilitate team and individual learning.	Type of Activity Parroting based exercise for finding solutions to given problems.

The table, I have alluded above, shows that Nepalese educational edifice for math learning is based on the traditional approach as a result; every movement in math curriculum becomes a failure in all cases.

Conceptual Framework of the Study

The conceptual framework grows out of the theoretical framework which relates to the specific research problem. According to Kumar (2009, p. 37), “The conceptual framework stems from the theoretical framework and concentrates usually on one section of the theoretical framework which becomes the basis of the study.”

Theoretical framework consists of the theories in which the study is embedded whereas conceptual framework describes the way or process to conduct the actual research. Here, actual research refers to methodology in general. The conceptual framework to conduct this research can be diagrammatically shown in figure.

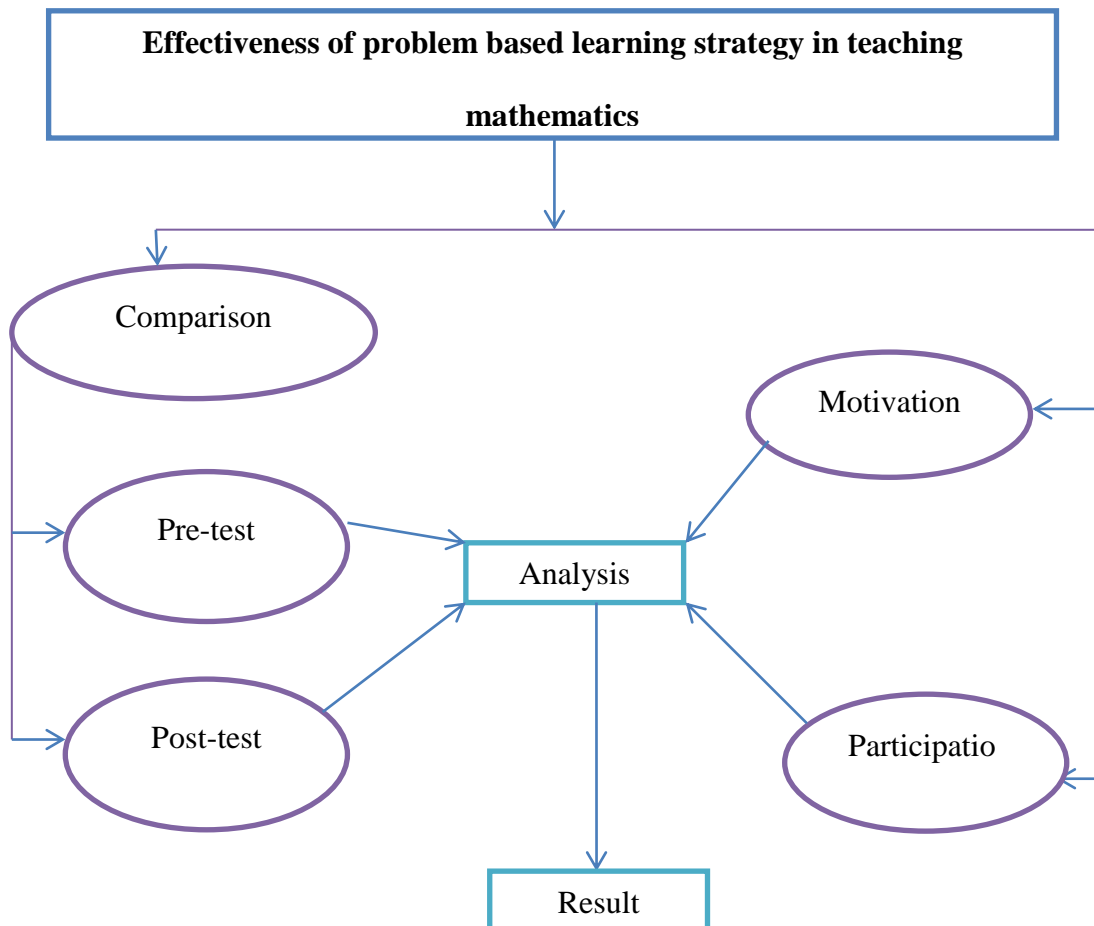


Figure II: Conceptual Framework

For the complement of the research, researcher administered two achievement tests and analyzed the result statistically to compare experimental and control group and also motivation and participation were observed and analyzed to explore the effectiveness of Krall's problem based learning strategy.

CHAPTER III

RESEARH METHODOLOGY

In this chapter express about the Research Design, Sample and Population, Variables of the Study, Data collection tools, Scores of data collection, Determination of Reliability and Validity of Data Collection Tools, Data Collection Procedure and the way of Data Analysis. Apart from this Data section, this chapter includes ethical consideration throughout the research process.

Research Design

The researcher had used pre – test, post – test and non-equivalent group design for the purpose of the study which is presented in the following table.

Table II: Design of the study

Groups	Pre-test	Treatment	Post-test
Experiment (E)	T ₁	Krall's Problem based learning strategy (KPBLS)	T ₁
Control (C)	T ₂	Conventional problem solving strategy (CPSS)	T ₂

Where T₁ was pre-test given the students of experimental group and control group and T₂ was post-test given to the students of both group post-test given to the students.

This design was one of the most effective in minimizing the threats to experimental validity. For this study, two groups were generated homogeneous as nearly as possible on the basis of pre – test result with the establishment of two non-equivalent intact groups, experimental and control group. Experimental group received the experimental treatment whereas control group did not receive it.

Experimental group was taught by Krall's problem based learning strategy whereas control group was taught by using conventional problem solving strategy of teaching. Researcher own self had taught both groups for 4 weeks on the same unit of arithmetic and administered the post-test on both groups on the same unit. The achievement test paper was refined with the help of pilot study.

Phases of Experiment

There are mainly three phases in this research which are given below:

Pre Experimental Stage

It is the stage in which researcher has to test the event to identify present situation of any event before conduct the research detail information are collected regarding event. Prior the test of any proposal is prepared, than appropriate tools are selected. By using suitable tools sample is selected, by tossing method samples are divided into two different group i.e. experimental group and control group. Then the pre-test is taken of each group and mean value of each group is measured.

Experimental Stage

In this stage two separate groups were taught by different techniques i.e. experimental group was taught by using Krall's problem based learning strategy and all the possible extractions variables are controlled for the effectiveness this strategy, whereas controlled groups is taught by using conventional problem solving strategy. Such group is isolated from techniques of problem solving strategy in mathematics teaching.

Post Experimental Stage

It is the last stage of experiment in which two separate groups which had been taught by two different strategies during experimental stage are evaluated by taking their post-test and comparing mean value of each group obtained from pre-test and

post-test. As we found the mean value of experimental group is better than second are due to application of problem solving method due to any other sampling efforts. To know the accurate validity of our experiment t-test was taken by using appropriate.

Population of the Study

So far as the population of this study consists of the student in lower secondary level, class VIII in Kathmandu district. The study was conducted with two schools of Kathmandu metropolitan city, based on purposive sampling.

Sample of the Study

For sample of the study, researcher selected of students from Pinnacle Scholars' Academy as experimental group and students from New Arunodaya Secondary School as control group. These schools were selected by random sampling method from Kathmandu district where mathematics was taught.

First of all, pre-achievement test was taken to the whole students of grade VIII of both schools. A fair coin had tossed to determine the experimental and control group. In this process, Pinnacle Scholars' Academy was elected as experimental group and New Arunodaya School was elected as control group. Thirty students were selected as experimental group and twenty-seven students were selected as control group by coin tossed.

Data Collection Tools

Development of tools is very important in order to collect the required data. The type of tools to be used in any research largely depends on the declared objectives of the study. The researcher used achievement test (pre-test and post-test), teachings episodes (Appendix-H) and interview is tools (Appendix-F) for data collection.

Achievement Test

The achievement test paper was developed on the basis of mathematics curriculum of class -VIII. It included both subjective and objective type of questions (Appendix-C) constructed to find achievement of students. Achievement test consists of 14 questions where 6 were very short questions, 4 were short questions and 4 were long questions obtaining 1marks, 2 marks and 4 marks respectively.

Episode

The teaching episodes developed by the researcher on the basis of the theoretical framework of the problem based learning strategy were one of the tools for experimental group. The researcher developed 28 episodes for experimental group. Episodes were developed on the basis of Krall's problem based learning strategy (Appendix-I). On the basis of scope and sequence table of content of grade VIII mathematics curriculum, 6 periods to be needed for simple Interest, 8 periods to be needed for profit and loss, 6 periods to be needed to ratio and proportion and 6 periods to be needed for unitary method. The researcher developed 28 episodes in these topics. All these topics were developed and revised to maintain reliability and validity with the help of experts, subject teacher, supervisor and colleagues.

Interview

Researcher asked open questions in which the subject was encouraged to answer in his/her own words at some length. During the treatment period, the researcher conducted interviews with individual of some students of experimental group about the Krall's problem based learning strategy. This tool was used to find out the motivation, interest, curiosity, inner feeling, thinking and participation of students about the Krall's problem based learning strategy. The interview guideline was attached in the appendix-F.

Validation of the Tools

Since tools were valid for a particular purpose and particular group, the mathematics achievement test and teaching episodes were developed for measuring the problem solving performance as well as achievement of class –VIII students. For the estimation of the validity of this test, the tools were developed with the help of mathematics teachers, supervisor and other educators and also found out the item analysis of tests. Researcher administered the pilot test on Pranidi Secondary School for 20 items on 18 students and the score obtained by students was analysis by SPSS and got Cronbach's Alpha value 0.773 which shows that test is valid .Also researcher selected 14 questions from 20 questions by the value of Cronbach's Alpha for pre-test and post-test. The teaching episodes were constructed on the basis of five steps of Krall's problem based learning strategy. The suggestions from experts were included to bring necessary improvements in the tools for more validity. The validity of teaching episode was tested based on students' achievements. Those students who were taught by using Krall's problem based learning strategy could follow and apply five steps to solve the mathematics problem. So, those teaching episodes are quite valid. Therefore, it can be said that the tools were quite valid.

Calculation of Reliability

Reliability of the achievement test was determined through an application of split half reliability calculation of pilot test on 18 student of Pranidhi School. To obtain an estimate of the reliability of the test papered, the scores of 18 students identified by the letter A, B, C... R, in first column of the following table (see Appendix-D). In this table, scores of each items was shown. Data were analyzed by help of SPSS 21.0 and got Guttman Split Half Coefficient was 0.771. Which shows that test is reliable.

Dependent and independent variables

Prior to beginning of the experiment, the researcher might study the effect of variables. Variables are the conditions or characteristics that the researcher manipulates, controls or observes. The independent variables are the conditions or characteristics that the research manipulates or controls in his or her attempt to ascertain their relationship to observed phenomena. The dependent variables are the conditions or characteristics that appear or change as the experimenter introduces, removes or changes independent variables. In this study problem based learning strategy was independent variable whereas achievement was dependent variable.

Control Mechanism for Extraneous Variables

Extraneous variables are special type of independent variables that are of secondary interest of the researcher but controlled through research design or statistical procedures to increase the validity of the results. Same subject matter was taught in both groups, experimental and control, by researcher himself within equal time duration. Same test was administered in both groups, experimental and control before and after the experiment. Point scoring system was applied for the purpose of scoring the answer sheet. Interaction effect among students was controlled by maintaining the distance between two schools.

Control of Variables (Extraneous/ Confounding Variables)**Teacher's Variables**

To control the extraneous variables such as behavior, personality, emotion and qualification of the teacher, the researcher himself taught both the experimental and control groups.

Student's Variables

The researcher was of the opinion that some students' variables might have adverse effect on the validity of the experiment. They were excluded from the possible participation in the experiment. They were (i) irregular in the class, i.e. they were present in the class less than fifty percent of the working days of the school, (ii) over aged i.e. over fourteen years, (iii) taking regular tuition (iv) dull student i.e. had low marks and their class performance was not good in mathematics but in this experiment no such students were found.

Content

Same contents related simple interest, profit and loss, ratio and proportion and unitary method were taught to both experimental and control groups from the same curriculum.

Period of Experiment

Researcher himself taught for 4 weeks to both groups by using different strategies. Researcher used problem based learning strategy to teach the experimental group and conventional problem solving strategy to teach the control group.

Evaluation system

On end of the experiment, the same test was taken for both experimental and control group. The researcher himself marked the test paper of the students. So, the variation in marking of test paper was also reduced.

Scoring the data

Since the achievement test consisted of questions from different levels and types, each type of questions varied according to difficulty level. Knowledge level questions demand simple information which carries 1 mark each. The comprehensive level questions demand both information and carry 2 marks each whereas application

type of questions were basic level which demand knowledge as well as comprehensive level of 4 marks.

Experimental Validity Threats

Any uncontrolled extraneous variable affecting performances on the dependent variable are threats to the validity of an experiment (Gay, Mills and Airasion, 2012). Thus, it is necessary to control these threats to insure the validity of the experimental results. In this study, the internal and external validity threats were address in the following ways.

Threats to Internal Validity

Internal validity is the degree to which observed differences on the dependent variables, not some other, (Gay et al., 2012, p.253).threats to internal validity compromise researcher's correct conclusion about the existing relationship between dependent and independent variable. The following internal threats were addressed in this study.

History: History refers to any event such as endemic, epidemic measles, a bomb scare occurring during the study that is not part of the experimental treatment but may affect the dependent variable. But during experiment such historical event did not happened.

Maturation: Maturation refers to physical, intellectual and emotional changes that naturally occur within individuals over the period of time (Gay et al., 2012). In this study , these changes may affect participants performance on a measure of the dependent variables to remedy this problem , individuals of same grade level were selected as participants treatment did not lasting long time.

Testing: A potential threats to internal validity is that participants may become familiar with pre-test ,post-test and remember facts for later testing the study was best

on pre-test, post-test and there might be such solution to remedy this situation, experimenter administered two tests less frequency and some different were use on the post-test than those use in earlier testing.

Instrumentation: The measuring instrument is changed between pre and post testing, or a single measuring instrument is unreliable (Gay et al., 2012).The instrumentation threat refers to lack of consistency in measuring instruments that may result in and invalid assessment of performance to correct to this potential problem, the researcher had use standardized procedure that is same measuring instrument throughout the experiment.

Statistical Regression: Statistical regression refers to the tendency of participants who score highest on the pre-test to score lower on post-test and tendency of those who score lowest on pre-tests to score higher on a post-tests (Gay et al.,2012) in this study naturally intact groups were taken as experimental an control groups . Both the groups were mix ability.

Differential Selection: Differential selection of participants of is the selection of subject who have differences before the start of a study that may at least partially account for differences found in a post-test (Gay et al., 2012). To correct this potential problem to groups were selected within same locality and pre-test was used to check initial equivalence.

Mortality: Mortality or attrition refers to a reduction in the number of research participants during the study (Creswell 2014). Mortality creates problems with validity particularly when different group dropped out for difference region and with different frequency. But in this study no student dropped out during the experiment. Thus, same number and same respondents were involved in the pre-test and post-test.

Section Bios: The participants selected into treatment groups have different maturation rates. Selection interactions also occur with history and instrumentation. To address this problem, experimental and control groups were divided based on randomization.

Threats to External Validity

External validity is the degree to which study results are generalizable to groups and environments outside the experimental setting. “Threats to external validity are problems that threaten our ability to draw correct inferences from the sample data to other persons, setting, treatment variables and measures” (Creswell, 2014, p.306). The following external validity is problems external threats were addressed in this study:

Pre-test Treatment Interaction: Pre-test treatment interaction indicates that the pre-test sensitizes participants to aspects of the treatment and thus influences post-test scores. This would be minimal when the study is conducted with in very young pupils (Gay et al., 2012). In this study, the effects of the pre-test was be greatly diminished by maintaining one month gap between pre-test and post-test and students’ age.

Multiple Treatment Interaction: When participants receive more than one treatment, the effect of prior treatment can affect or interact with later treatment, limiting generalize. In this study, single treatment was used in experimental groups.

Researcher Effects: A researcher effect refers to conscious or unconscious actions of the researchers that affect participants’ performance and responses. It is difficult to identify researcher bias in the study. To counter this problem, the researcher had become as a strivers to avoid communicating emotions and expectations to students in the study. It also reduced by blind scoring, in which the researcher does not know whose performance is being evaluated.

Reactive rearrangement: In experimental design, the experimenter may create highly artificial environment but not easily generalize to non-experimental setting for his/her experiment which is known as reactive rearrangement. To reduce reactive rearrangement affects students were formed in naturally assembled class.

Data Collection Procedures

The researcher has granted permission from the schools and subject teachers to conduct experiment. In the maiden phase of experiment students of both groups were assessed in term of mathematics achievement test for the purpose of identifying knowledge level of participants of the groups. Then the results of pre-test were analyzed, quantitatively. Experimental group had received regular treatment of problem based learning and control group did not receive such treatment. During the classroom students were solving the mathematics problems with interaction each other. After the classroom experiment, students in both groups were again assessed in term of same mathematics achievement test for the purpose of determining their progress. Problem based learning of post-test were analyzed quantitatively. Finally a closed form of questionnaire was administered in experimental group in order to explore students' attitude towards use of problem based learning in teaching mathematics. Then interview was conducted to the students from experimental group. In interviews, students were asked to answer questions related to effectiveness of problem based learning in teaching mathematics. Also teacher own self observed classroom in terms of questions developed related to effectiveness of problem based learning in teaching mathematics.

Data Analysis and Interpretation Procedure

Before analyzing the data, it is necessary for organization of data and so that data had been organized by using computer. And verbal data had been converted into

suitable numerical form. This study verged on quantitative and therefore preliminary part of analysis was based on descriptive statistics. After the injection of descriptive statistics, the researcher used inferential statistics: t-test or the SPSS 21.0 statistical package was used for the purpose of analyzing and interpreting the test results. Finally, interview data were analyzed through thematic approach of analysis in which theme of each individual's response had been coded for generating final theme This analysis process involved organization of data, transcription of the data coding the data and triangulation of data with theory.

Ethical Consideration

In the research work, a numerous ethical issues were considered in order to make standardization in data collection procedures and conformity in report writing. In this experimental design the following ethical issues were considered.

Institutional approval: Researcher has granted permission from institutions prior to planning or conducting experiment providing accurate information about his research proposal. And experiment was conducted in accordance with the approved research protocol.

Informed Consent: Before collecting required data or conduction actual experiment, participants had been clearly informed about the purpose of the study, use of its results, duration of the experiment, and possible risk factors in this experiment as well as responsibilities of each party. After making consent with the participants, the experiment was started.

Filming or Recording: Researcher obtained consent from research participants prior to filming or recording them in any form.

Language: Researcher had used appropriate language that was reasonably understandable to all participants and researcher has not fabricated data or falsified result in his publication.

CHAPTER IV

ANALYSIS AND INTERPRETATION OF DATA

The most important part of the study is to analyze the collected data. The present study entitled "Effectiveness of problem-based learning in teaching mathematics was an experimental research involving pre- test, post- test nonequivalent control group design. The main objectives of this study was to compare achievement score of students in mathematics taught by problem based learning and conventional problem solving strategy of teaching in grade VIII on the arithmetic

This chapter deals with the results of statistical analysis and interpretation of data from the achievement score of the sample students. For the purpose of analyzing statistical data, SPSS 21.0 statistical analysis software was used setting at the 0.05 confidence level. The researcher analyzed and interpreted the data under the following headings.

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

An individual score of students from both groups in pretest were presented in appendix-B. Summary of statistical in Appendix-B the pretest raw scores of students of both groups were presented. The summary of statistical calculation on the pretest result is presented in the following table III.

Table III: Results of independent t-test on the pre-test

Group	Mean	S.D	t-value
Control (N=27)	18.03	5.64	0.656
Experimental (N=30)	18.96	5.05	

An independent- sample t-test was used to compare the students' mean achievement score for control and experimental groups. The above table reveals that, there was no significant difference in scores for control group students (mean = 18.03, SD = 5.64) and experimental students (mean 18.96, SD = 5.05) in pre test

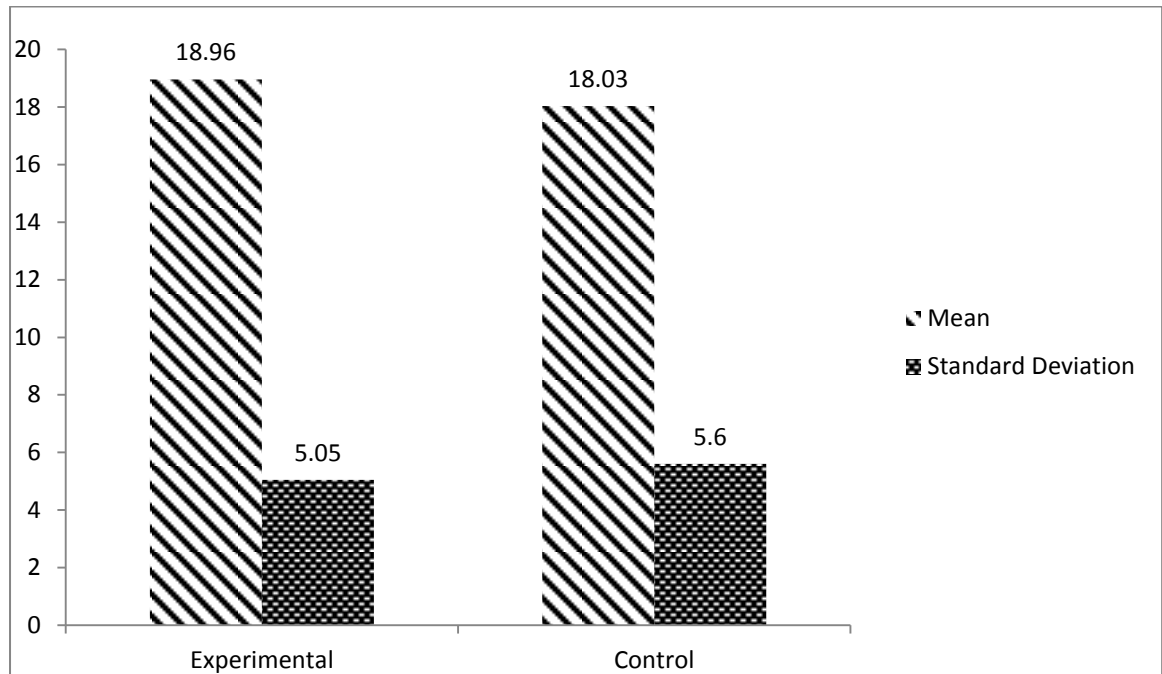


Figure III: Comparison of Students' Achievement in pre test

In this diagram, the mean and standard deviation obtained by the students of each group in the pre-test raw score have been shown. The diagram is more interesting for comparison. This shows that there is no difference in achievement scores of both groups of students. So, this condition was very suitable to conduct the experimental design for this study.

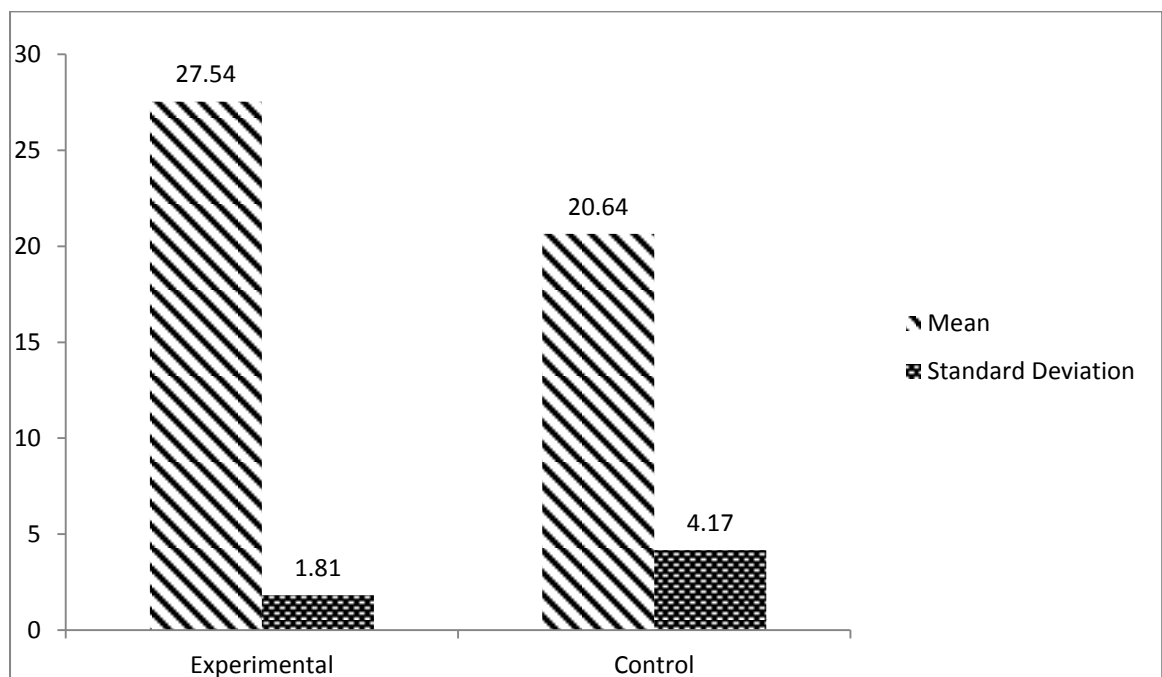
Comparison of Achievement Score of Control and Experimental Group in Post-test Result

After providing the certain treatment to the experimental group, control and experimental groups were again (Appendix- A) assessed in terms of same test namely post-test. A of individual score of students on post-test is presented in Appendix A. the summary of independent t-test in table IV:

Table IV: Results of independent t-test on the post-test

Group	Mean	S.D	t- value
Control (N=27)	20.64	4.17	-8.247
Experimental (N=30)	27.54	1.81	

An independent-sample t-test was carried out to compare students' achievement scores for control and experimental groups. The above table exhibits that there is a statistically significant difference in scores for control group student (mean = 20.64, SD = 4.17) and experimental students (mean = 27.54, SD = 1.81) with $|t| = 8.247 > 1.96$ at 0.05 level of significant, and conclude that there is significant difference between the achievement of students in experiment and control group. Moreover, the mean achievement of experimental group was higher than control group. Thus, results of his study succinctly demonstrate that problem based learning method has positive impact on students' achievement in the mathematic.

**Figure IV: Comparison of Students' Achievement in post test**

The mean and standard deviation obtained by the students of experimental and control groups in the post-test have been presented in figure IV. The column of experimental group of students is longer than that of control group students. This shows that there is significance difference in achievement of mathematics in topic simple interest unitary method profit and loss and ratio and proportion between experimental and control group of students. The difference between the mean and standard deviation on the post-test of experimental and control group was 6.9 and 2.36 respectively. Therefore, the figure IV indicates that the problem based learning strategy of teaching mathematics in aforementioned topics is more effective than the conventional problem solving strategy in class VIII. Consequently, the problem based learning strategy in teaching mathematics was found to have achieved higher achievement than conventional problem solving strategy in higher secondary school.

Qualitative Data Analysis

The researcher collected qualitative data as well to fulfill the objectives intended. It is believed that statistical tools in research works cannot support to obtain opinions, beliefs and feelings of respondents. So, the researcher in this research used interview as the tool to understand students' perception on using problem based learning strategy in mathematics in terms of motivation and classroom participation.

Student's Motivation

Motivation is a potential to direct behavior that is built into the system that controls emotion. This potential may be manifested in cognition and/ or behavior. Motivation is considered as a potential to direct ordering to the definition, students motivation may be manifested in cognition, emotion and/ or behavior. To measure students motivation the modified motivation scale used by Luc G. Pelletier, Michelle Fortier, Robert J. Vallerand, Nathalie M. Brière, Kim M. Tuson and Marc R. Blais

(1995). In this research researcher had selected 5 students so as to response regarding 5 items. The researcher had conducted a semi structure interview with five students to explore whether they are motivated by problem based learning strategy or not, which are given below.

Researcher: Do you think problem based learning strategy helps you to achieve better marks? How?

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

Student 'B': *Of course, it is practical.*

Student 'C': *Sure, it helps to solve all kind of problems.*

Student 'D': *Yes, I entertained solving mathematical problem by using this strategy.*

Student 'E': *It is one of the easiest ways of solving mathematical problem.*

From the above responses, it is conclude that problem based learning strategy helps students to achieve good marks as it is stepwise, practical and one of the easiest ways of solving mathematical problems. They were more motivated because they were provided with authentic and real world problems have the opportunity to work in small collaborative teams.

Researcher: Is this method practical and student centered method? How did you feel?

Students 'A': *Yes, teaching with problem based learning strategy is interesting sequential and easy to understand*

Student 'B': *I feel that all students are confidently solving mathematics problems and participate in learning activities without hesitation.*

Student 'C': *Problem based learning strategy helps student to understand subject matter and I also fell that my place in mathematics.*

Student 'D': *It encourages me to participate in classroom activities.*

The answer of the above questions shows that the use of *problem based learning strategy* in teaching mathematics is more effective than using conventional problem solving strategy. It concludes that problem based learning strategy is self-directed learning strategy where students work collaboratively in small groups to investigate open-ended relative case scenarios’.

Researcher: Do you feel comfortable in classroom?

Student 'A': *Yes, because it is student oriented class.*

Student 'B': *Sure, it helps to derive solutions with classroom discussion.*

Student 'C': *Of course, it is easy to understand and co-operative.*

Student 'D': *Yes, I would like to learn all content through problem based learning strategy.*

Student 'E': *Sure, I can think creatively and critically when using this strategy.*

Above responses concluded that most of the students viewed that they entertained mathematical class in which *problem based learning strategy* is used because it is simple, easy to understand, focus on group discussion and it promotes creativity on students. Problem based learning motivates students to connect with content areas text while increasing their knowledge of the topic. It is way to engage and give them ownership over their own learning.

Researcher: Is this strategy improving your problem solving ability? How?

Student 'A': *Obviously, It gives me to know easier ways of learning on arithmetic*

Student 'B': *Sure, after applying this strategy, I really think myself more confident in solving mathematical problems.*

Student 'C': *Of course, I would be confused if I was not applying this strategy.*

Student 'D': *Sure, it helps to concern about what is given and what is our goal.*

Student 'E': *Yes, it assists to discover problem solving techniques of mathematics problem.*

Above responses of respondent concluded that most of the students opined than problem based learning strategy assist them to build up confidence on solving mathematical problem and it solving mathematical problems. So problem based learning is a student centered pedagogy in which student learn about a subject through the experience of solving an open-ended problem found in trigger material.

Researcher: Did you find any changes in you while solving mathematical problems after using problem based learning strategy?

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

Student 'B': *Sure, I find my place for me as well in mathematics.*

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

Student 'D': *yes, I take part in the classroom regularly.*

Student 'E': *obviously, I fell as if I can support my friend as well to solve mathematical problem.*

From above mention responses, it concluded that students found many changes in them after using problem based learning strategy. They took class regularly, did homework daily and felt more confidence in solving mathematical problem. Problem based learning strategy is student centered approach to learning that involves group of students working to solve a real-world problem, quite different conventional teaching method of a teacher presenting fact and concept about a specific subject to a classroom of students.

Classroom Participation of students

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

their own through participation. Especially problem based learning strategy is focused on classroom participation. So the researcher aims to explore whether students are motivated to participate in the classroom activity while they are taught by using problem based learning strategy in classroom. In this research researcher had selected 5 students so as to response regarding 5 items. The researcher had conducted a semi structure interview with five students to explore whether they are motivated to participate in classroom activities by problem based learning strategy or not. This was mentioned below.

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

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

Student 'B': Yes, it is easier way to solve mathematical problem and it is sequential.

Student 'C': sure, it is contextual so now days I engaged to solve mathematical problem.

Student D: It is interactive method.

Most of the students viewed that they take part in the classroom activities while problem based learning strategy is used in teaching mathematics because it is motivating, sequential, contextual and interactive. It concluded that problem based learning strategy is more fascinating, stimulating and one of the good learning methods because it is more flexible and interesting to students.

Researcher: Do you do your homework regularly?

Student 'A': Yes, it makes mathematics problem much easier than usual.

Student 'B': Sure, it assists to discover multiple ways of solving problem.

Student 'C': Of course, it helps to solve verity of mathematical problems.

Student 'D': It makes my study more entertainment.

Most of the students viewed that they do their homework regularly while Krall's problem base learning strategy is used in teaching mathematics because it is easier, discover multiple ways, verity of solution and more entertained. So problem based learning addressing the need to promote lifelong learning through the process of inquiry and constructivist learning.

Researcher: Do you participate in classroom discussion while problems posed by your teacher? Why?

Student 'A': Yes, problem based learning strategy helps me to discover and present solutions in groups.

Student 'B': Sure, I can get different solution from participant.

Student 'C': Of course, It makes me autonomous to solve mathematical problems.

Student 'D': Yes, We solve the problem by entertainment.

Student 'E': Obviously, problem based learning strategy is student centered and existing to apply mathematical problem.

From the above discussion it can be concluded that problem based learning strategy motivate students take part in the classroom discussion as it helps to discover alternative solution and it focuses on participatory approach. Problem based learning strategy represents a paradigm shift from traditional teaching and learning philosophy, which is more often lecture based method.

Researcher: Did you get chance to communicate with teacher in the classroom while problem based learning strategy is used?

Student 'A': Yes, it is student centered method so we can easily communicate each other.

Student 'B': Obviously, problem based learning strategy focuses on student activities.

Student 'C': *Sure, in this strategy teacher stands as a facilitator, planner and motivator of the students.*

Student 'D': *Sure, it focuses on classroom participation.*

Student 'E': *Of course it emphasis on equal teacher student participation.*

Most of the student accepted that they get sufficient time to communicate in the classroom and this strategy focus on participation and communication. Not only this strategy emphasized on students as active participant and teacher as facilitator.

Researcher: Does problem based learning strategy attracts your attention to solve any mathematical problem?

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

Student 'B': *Sure, It is applicable in multiple areas like set simple interest, unitary method and construction.*

Student 'C': *Sure, It is not boring even if I solve mathematical problem using this strategy.*

Most of the respondents said that they pay attention in the classroom while problem based learning strategy is used. Because it is practical, applicable in multiple areas and it is entertaining. So PBL, is one student centered pedagogical approach to learning that helps students build the abstract reasoning skills, versatile communication skills, administration skills and problem solving skills.

Researcher: Does problem based learning strategy motivates you to present mathematical solution in the classroom? How?

Student 'A': *Sure, it promotes to explore solutions on my own.*

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

Student 'C': *Of course, I get immediate feedback and do necessary correction.*

Student 'D': It helps to avoid hesitation of presenting solutions in group.

So it can be concluded that students motivated to present in the classroom using problem based learning strategy. It is because it grows autonomous learners and builds up confident in them. On the other hand, as it promotes the participation, the participants get immediate feedback which helps them to receive whether rewards and necessary correction. So this student centered and new pedagogical approach problem based learning is constructivist approach to learning plays vital role.

On the basis of qualitative data analysis a brief conclusion can be derived from the multiple responses. Students are highly motivated to solve mathematics problem by using problem based learning strategy. Students are encouraged to solve problems on their own as problem based learning strategy is a student centered strategy. Teachers are taken as facilitator, planner, guide and motivator whereas learners are active participant. On the other hand, Students take part in the classroom activity as problem based learning strategy focuses on classroom discussion and participation. Students do their homework regularly and perform their solution without hesitation. So, it can be concluded that problem based learning strategy is one of the best strategy in today's class to teach and learn mathematics.

The researcher carried out different activities upon experimental groups for meeting the intending objectives. Some striking activities and their status have been presented in Appendix-G

CHAPTER V

SUMMARY, FINDING, CONCLUSION AND RECOMMENDATIONS

This chapter synthesizes the analysis of the data gathered from primary and secondary sources as finding the study and draws the conclusion of the study.

And finally, the implication of the research and recommendation for future areas of researcher are presented.

Summary and Findings

The pre-test study intended to answer the question whether the performance of the students of secondary level taught by problem based learning strategy affect the mathematics achievement as compared to the performance of them taught by conventional problem solving strategy.

For the data collection of the study, the researcher developed and tested the reliability of achievement test paper (pilot-test) before their administration. The test was consisted of objective multiple choice type items and subjective short and long answer type of question on the area of simple interest, profit and loss, unitary method and ratio and proportion from grade VIII. The reliability of Guttman Split-Half coefficient of pilot test was found to be 0.771.

A pre-test, post-test and non-equivalent control groups design was adopted for the purpose of this study. Students of grade-VIII in Pinnacle Scholars' Academy and New Arunodaya School were chosen for sampling purpose. Both groups were established on the basis of the pre-test results. Both experimental and control groups were taught by the researcher himself on the same selected units. The instruction period was 28 days only. A post-test was administered to both the groups providing necessary instruction for usual period on the same units. Along with other statistical measures; t-test was applied in order to ascertain the difference between two groups.

The data were analyzed and interpreted statistically by SPSS 21.0 to find the conclusion. Thus, the following were the main finding of the study:

- There was no significant difference between the mean achievement of control group students and experimental group students in the pre-test.
- The men achievement of experimental group students was higher than the control group in posttest.
- The achievement of experimental group which has taught by using Krall's problem based learning strategy of teaching has been found significantly higher than the achievement of the control group which was taught by using conventional problem solving of teaching mathematics grade VIII.
- The students of experimental group were found to be more motivated and encouraging while solving mathematics problems that than of control group.
- The classroom environment was friendly; students were engaged to learning among the experimental group as compared with the students of control group.

Conclusion of the Study

The problem based learning strategy is the best strategy for improving mathematics problem solving of students in the context of Nepal. Taught by problem based learning strategy not only increase students' score in mathematics but it helps students to become more creative, independence as well as improve their deep understanding skills. Thus problem based learning strategy in teaching mathematics provides an ample opportunity to each individual for unlocking mathematics higher order thinking by open-ended and situation through active participation. More importantly, it up-rise students' mathematics problem solving because problem based learning strategy helps students to reconstruct their existing state of knowledge and enforces them to engage in enquiry based activities such as searching application of

construction. Furthermore, by teaching problem based learning strategy in mathematics enables students to use existing cognitive and constructive skills to develop efficiency, experiences autonomy and hence confidence in their abstract problem-solving. From the finding of the study, it conclude that students taught by Krall's problem based learning strategy support to students to increase their achievements in mathematics, motivate students to participate in the interaction in the class room, it encourages the students in subject matter and they are regular in class room and to engage in class works and homework's. Therefore problem based learning strategy is necessary for teaching mathematics that helps students build the abstract reasoning skills, versatile communication skills, problem solving skills, higher order thinking, knowledge transformation skills and deep understanding skills.

The Implication of the Research

On the basis of finding of the study some measures have been recommended for the improvement of the teaching learning situation in secondary level classes as below:

- The mathematics teacher should be encouraged to use Krall's problem based learning strategy in teaching mathematics
- The mathematics teacher should be taken himself as a good manager and a guide in teaching mathematics.
- Students should be encouraged to get involved in active participation in classroom activities.
- It is suggested that ones the teaching technique is accomplished by pupils, the teacher should checks comment, evaluate, suggest and return back to students immediately.

Recommendations for Further Study

This study has focused on the improvement of students' achievement through teaching Krall's problem based learning strategy based on an experimental design with middle size of sample. Others researcher may conduct a study within large sample in order to increase the effectiveness of problem based learning strategy in mathematics lesson. Based on the research, the research has made following recommendation for the further study:

- This experimental study was conducted with one experimental and one control group of grade-VIII form secondary schools of Kathmandu district on the mathematics. Hence, the researcher should not find that this strategy is applicable in the classrooms of whole parts of Nepal .Furthermore and large research studies must be designed and carried out in order to investigate the effectiveness of the technique in large sample and various schools of different parts of Nepal.
- It would be worthwhile to study, the opinions and attitudes of teaches and pupils toward the use of appropriate technique with teaching materials.
- In this study, the performance score of experimental group is highly significant than control groups. Therefore, workshops, seminars and conferences of the teachers should be organized, under the leadership of district education officer. So that improvement in the teaching learning activities and use of relevant technique of teaching mathematics can be promoted at the district level.
- It is suggested that the curriculum designer, test book writer resource person and teacher's training program should be emphasized on Krall' problem based learning strategy.

REFERENCES

- Ajai, J.T., Imoko, B.I., & Ijenkeli, E. (2013). Comparison of the learning effectiveness of problem based learning (PBL) and conventional method of the teaching algebra. *Journal of Education and Practice, 4*(1).
- Ali, R., Hukamdad, B., Akhter, A., & Khan, A. (2010). Effect of using problem solving method in teaching mathematics on the achievement of mathematics students. *Asian Social Science, 6*, pp. 67-72. Retrieved from: www.ccsenet.org/ass.
- Ali, R., Akhter, A., Shahzad, S., Sultana, N., & Ramzan, M. (2011). The impact of motivation on students' academic achievement in problem based learning environment. *International Journal of Academic Research, 3*, pp. 306-309. Retrieved from: www.ijar.lit.az.
- Bhatta, S. (2016). *Effectiveness of problem solving method in learning mathematics at secondary level*. An Unpublished Thesis, Department of Mathematics Education, TU: Kirtipur.
- Creswell, J. (2014). *Educational research: planning, conducting, and evaluating quantitative and qualitative research*. Delhi: PHI Learning Private Limited.
- Duch, B. J., Groh, S.E., & Allen, D.E. (2001). *The power of problem-based learning* (p. 47). Virginia: Stylus Publishing.
- Gay, L.R., Mills, G.E., & Airasian, P. (2012). *Educational research: competences for analysis and applications*. New York, Pearson Education.
- Gordon, P. R., Rogers, A. M., Comfort, M., Gavula, M., & Mcgee, B. P. (2001). A taste of problem-based learning increases achievement of urban minority middle-school students. *Education Horizon*, pp. 171-175. *of Education on Science*. Jakrata, Indonesia.

- Government of Nepal. (2014). National assessment report -2011. Kathmandu: *Author*.
- Government of Nepal. (2014). National assessment report -2013. Kathmandu: *Author*.
- Herreid, C. F. (2003). The death of problem based learning. *Journal of College of Science Teaching*, 32(6).
- Hoffman, B., & Ritchie, D. (1997). Using multimedia to overcome the problems with problem based learning. *Instructional Science*, pp.97-115
- Hung, W. (2009). The 9-step problem design process for problem-based learning: application of the 3C3R model. *Educational Research Review*, pp.188-141.
- Krall, G. (2012). Problem based learning in mathematics planning session. *NC project based learning conference*. Durham: New Tech Network.
- Kumar, R. (2009). *Research methodology*. New Delhi. Doring Kindersly.
- MacMath, S., Wallace, J., & Chi, X. (2009, November). Problem based learning in mathematics: A tool for developing students' conceptual knowledge. *Research into Practice*, pp. 1-4.
- Mushlihuiddin, R., Nurafifah, R., & Irvan, R. (2018), The effectiveness of problem-based learning on students' problem solving ability in vector analysis course. *Journal of physic; Conference Series, Volume 948, 1st International conference*
- Olufemi, A. (2012). Investigating the effectiveness of problem based learning in the further mathematics classroom. *An Unpublished Thesis*, University of South Africa. Retrieved from: <http://hdl.handle.net>.
- Poudel, H. (2015). *Effectiveness of problem solving method in teaching mathematics in secondary level of grade IX*. An Unpublished M.Ed. Thesis, T.U: Kirtipur.
- Savin-Barden, M., & Major, C. H. (2004). *Foundations of problem-based learning* Cornwall: MPG Books.

Slinder, T. M. (2002). *The effectiveness problem based learning in the high school science classroom*. An unpublished Manuscript, Wichita State University.

Retrieved from: <http://hdl.handle.net>.

Appendix-A

Score of students in Achievement Test in Pre-test and Post-Test of Experimental

Group

SN	Groups	Pre-Test	Post-Test
1	Experimental Group	26.00	27.00
2	Experimental Group	23.00	24.00
3	Experimental Group	20.00	27.00
4	Experimental Group	23.00	29.00
5	Experimental Group	18.00	30.00
6	Experimental Group	20.00	29.00
7	Experimental Group	20.00	25.00
8	Experimental Group	19.00	30.00
9	Experimental Group	19.00	29.00
10	Experimental Group	21.00	29.00
11	Experimental Group	18.00	26.00
12	Experimental Group	5.00	27.00
13	Experimental Group	23.00	27.00
14	Experimental Group	23.00	29.00
15	Experimental Group	12.00	27.00
16	Experimental Group	14.00	25.00
17	Experimental Group	24.00	30.00
18	Experimental Group	14.00	29.00
19	Experimental Group	24.00	27.00
20	Experimental Group	23.00	29.00
21	Experimental Group	21.00	27.00

22	Experimental Group	23.00	25.00
23	Experimental Group	10.00	29.00
24	Experimental Group	23.00	26.00
25	Experimental Group	23.00	30.00
26	Experimental Group	10.00	28.00
27	Experimental Group	19.00	27.00
28	Experimental Group	21.00	29.00
29	Experimental Group	17.00	25.00
30	Experimental Group	13.00	25.00

Appendix-B

Score of students in Achievement Test in Pre-test and Post-Test of Control

	Group		
SN	Groups	Pre-Test	Post-Test
1	Control Group	8.00	24.00
2	Control Group	12.00	21.00
3	Control Group	13.00	16.00
4	Control Group	14.00	24.00
5	Control Group	15.00	18.00
6	Control Group	28.00	30.00
7	Control Group	16.00	22.00
8	Control Group	18.00	19.00
9	Control Group	12.00	27.00
10	Control Group	17.00	16.00
11	Control Group	15.00	18.00
12	Control Group	7.00	20.00
13	Control Group	22.00	23.00
14	Control Group	25.00	22.00
15	Control Group	23.00	21.00
16	Control Group	18.00	18.00
17	Control Group	21.00	17.00
18	Control Group	23.00	22.00
19	Control Group	28.00	30.00
20	Control Group	26.00	20.00
21	Control Group	23.00	24.00

22	Control Group	16.00	17.00
23	Control Group	17.00	17.00
24	Control Group	13.00	13.00
25	Control Group	23.00	23.00
26	Control Group	16.00	17.00
27	Control Group	18.00	18.00

Appendix-C

Achievement Test Items

Class: VIII

Full marks: 30

Subject: Compulsory Mathematics

Pass marks: 9.6

Attempt the entire question

Group: A

1.5 ×= 6

1. Which one is incorrect?

i) $I = \frac{P \times T \times R}{100}$

iii) $R = \frac{i \times 100}{P \times T}$

ii) $P = \frac{I \times 100}{R \times A}$

iv) $T = \frac{I \times 100}{P \times R}$

2. If 6, 8 and 12 are the terms of a proportion, which one the fourth proportion?

i) 14

iii) 16

ii) 18

iv) 20

3. A TV is purchased at Rs. 5000 and sold at Rs. 4000, find the loss amount.

i) Rs. 500

iii) Rs. 1000

ii) Rs.1500

iv) Rs. 2000

4. If the cost of 5 pens is Rs. 35, what is the cost of 1 pen?

i) Rs. 5

ii) Rs. 6

ii) Rs. 7

iv) Rs. 8

5. What is the ratio of 250m and 1km?

i) 1:4

ii) 2:3

iii) 1:3

iv) 3:4

6. If SP = 550 and CP = 500, what is the profit percent?

i) 5%

iii) 10%

ii) 15%

iv) 20%

Group B **$2 \times 4 = 8$**

7. Find the interest on Rs 5000 at 10% per year for 4 years?
8. If the cost of 15 copies is Rs 300, find the cost of 2 dozens of copies.
9. Hari bought an article at Rs. 600 and sold it at Rs.900. Find the profit percent.
10. In how many years will Rs 800 produce Rs 4000 as interest at 10% per year?

Group C **$4 \times 4 = 16$**

11. Find the simple interest on Rs 2160 at the rate of 20% per year for 4 years. In how many years will Rs 1800 produce the same interest at 12% per annum?
12. 18 men can dig a field in 24 days working 6 hours a day. How many men are required to dig the field 18 days working 8 hours a day?
13. The monthly income of Ramesh is Rs. 15000. He spends 40% of his income on food, 20% on house rent 15% on his children education. Find the expenditure on each item. How much money does he save in a month?
14. Derive the formula of simple interest.

Appendix-D

Raw Score of Pilot Test for Reliability of the Test

Name/ Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A	1	1	1	1	0	0	1	1	2	2	2	2	2	2	2	2	4	4	4	4
B	1	1	1	1	1	1	1	1	0	2	1	1	0	2	2	2	4	4	4	4
C	1	0	1	1	0	0	1	0	0	0	2	0	0	0	2	0	0	4	0	4
D	1	0	1	1	1	0	1	1	0	1	2	2	0	2	2	0	0	2	2	4
E	1	1	1	1	0	1	1	1	2	2	2	2	0	2	2	2	4	4	4	4
F	0	0	0	0	0	1	1	1	0	2	2	0	0	2	2	2	2	2	0	1
G	1	1	1	1	1	0	0	1	2	1	2	1	0	2	2	2	4	4	4	4
H	1	1	0	0	0	1	1	1	0	0	2	2	0	0	2	3	3	0	2	4
I	0	1	1	0	0	1	2	0	0	2	0	0	0	1	4	0	4	4	4	2
J	0	0	0	0	0	0	1	1	0	2	2	2	0	0	2	0	3	0	0	4
K	0	1	0	1	1	0	1	1	0	0	2	2	0	2	2	2	4	4	4	0
L	1	1	0	0	1	0	1	1	0	0	2	1	0	2	2	2	1	4	3	1
M	0	1	0	0	0	0	1	0	0	1	0	0	0	0	2	2	3	4	4	0
N	1	1	0	1	0	1	1	1	0	0	2	2	0	0	2	2	0	4	3	0
O	1	1	0	1	0	1	1	1	0	1	2	2	0	2	2	2	1	3	4	2
P	1	1	1	1	1	1	1	1	0	2	2	2	1	2	2	2	4	4	4	4
Q	0	1	0	0	0	0	1	0	0	2	0	2	0	2	2	2	4	2	4	4
R	0	1	0	0	0	1	2	0	2	0	0	1	0	2	2	2	3	2	2	2

Reliability Statistics

Cronbach's Alpha	Part 1	Value	.499
		N of Items	10 ^a
	Part 2	Value	.556
		N of Items	10 ^b
	Total N of Items		20
Correlation Between Forms			.799
Spearman-Brown Coefficient	Equal Length		.888
	Unequal Length		.888
Guttman Split-Half Coefficient			.771

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
VAR00001	25.3333	49.529	.389	.710
VAR00002	25.1667	49.206	.523	.707
VAR00003	25.5000	48.382	.546	.702
VAR00004	25.3889	48.722	.496	.705
VAR00005	25.6111	50.134	.314	.714
VAR00006	25.4444	51.438	.112	.723
VAR00007	24.8889	54.105	-.286	.738
VAR00008	25.2222	50.183	.326	.714
VAR00009	25.5000	46.853	.422	.701
VAR00010	24.8333	47.559	.335	.708
VAR00011	24.4444	51.438	.029	.733
VAR00012	24.6111	48.252	.306	.711
VAR00013	25.7778	48.654	.503	.704
VAR00014	24.5556	45.203	.526	.691
VAR00015	23.8333	52.735	-.063	.731
VAR00016	24.3333	48.588	.242	.716
VAR00017	23.2778	41.271	.435	.698
VAR00018	22.8889	45.516	.270	.719
VAR00019	23.0556	38.997	.586	.674
VAR00020	23.2778	45.154	.211	.734

Scale Statistics

	Mean	Variance	Std. Deviation	N of Items
Part 1	6.5556	6.144	2.47867	10 ^a
Part 2	19.3889	26.134	5.11214	10 ^b
Both Parts	25.9444	52.526	7.24749	20

Appendix-E

Item Analysis

Reliability Statistics

Cranach's Alpha	Cranach's Alpha Based on Standardized Items	Number of Items
.773	.755	19

Note: Item no. 15 was canceled.

Scale Statistics

Mean	Variance	S. D	Number of Items
12.3333	13.294	3.64611	19

Item-Total Statistics

Items	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
1	25.3333	49.529	.389	.710
2	25.1667	49.206	.523	.707
3	25.5000	48.382	.546	.702
4	25.3889	48.722	.496	.705
5	25.6111	50.134	.314	.714
6	25.4444	51.438	.112	.723
7	24.8889	54.105	-.286	.738
8	25.2222	50.183	.326	.714
9	25.5000	46.853	.422	.701
10	24.8333	47.559	.335	.708
11	24.4444	51.438	.029	.733
12	24.6111	48.252	.306	.711
13	25.7778	48.654	.503	.704
14	24.5556	45.203	.526	.691
15	23.8333	52.735	-.063	.731
16	24.3333	48.588	.242	.716
17	23.2778	41.271	.435	.698
18	22.8889	45.516	.270	.719
19	23.0556	38.997	.586	.674
20	23.2778	45.154	.211	.734

Appendix-F

Interview format for key informants

Name of student

Permanent Address Temporary

Address.....

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

Motivation

- *Do you think Krall's problem based strategy helps you to achieve good marks? How?*
- *Is problem based learning strategy practical and student centered method? How did you feel?*
- *Do you feel comfortable in classroom?*
- *Is this strategy improving your problem solving ability? How?*
- *Did you find any changes in you while solving mathematical problems after using Krall' problem based learning strategy?*

Classroom Participation

- *Do you engage yourself to solve mathematical problem? Why?*
- *Do you do your homework regularly?*
- *Do you participate in classroom discussion while problems posed by your teacher? Why?*
- *Did you get chance to communicate with teacher in the classroom while Krall's problem based learning strategy is used?*
- *Does Krall's problem based learning strategy attract your attention to solve any mathematical problem?*

Interviewer...

Date.....

Appendix-G

Result of observed activities in Experimental Group

SN	Problem based learning strategy related Activities	Observed Frequency (%)
1.	<p>Students' Motivation</p> <ul style="list-style-type: none">a. Students easily solved mathematics problem used by this strategy.b. Students entertained mathematical class in which this strategy was used.c. Students felt more confidence in solving mathematical problem.	89
2.	<p>Classroom Interaction</p> <ul style="list-style-type: none">a. Students take part in classroom discussion.b. Students work on small and interactive group for sharing and organizing knowledge.c. Students engaged in various types of facilities.	91
3	<p>Classroom participation</p> <ul style="list-style-type: none">a. Students took class regularly, did homework daily and felt more confidence in solving mathematical problem.	97

Appendix-H

Teaching Episode I

Subject: Mathematics

Class: VIII

Topic: Calculation of Simple Interest

Time: 45 min.

Specific objectives

At the end of this class, students will be able to derive the formula of simple interest with examples.

Teaching learning activities

i) Posing a problem

In this phase, tutor will ask about definition of simple interest and student are themselves define simple interest and present with a problem which is complex and ill-structured concerned with real world phenomena.

ii) Work on the problem

In this phase, tutor will divide small and creative group for sharing and organizing their ideas and tutor should construe the students' ownership as in the critical understanding and clearly questions maintaining good mathematical thinking environment.

iii) Intervention as question arise

In this phase, students will engage in different types of facilities and discuss the given questions.

What is simple interest?

What is principle?

What is time in a year?

What is rate of interest?

Tutor will provide the chance to students where they will share and exchanging work with other groups.

iv) Students apply scaffolding instruction

In this phase, tutor will watch over the students work and finally tutor will provide feedback.

v) A solution reached

Tutor will ask final solution and discuss about the solving process for each group and finally tutor give final solution.

$$\text{Simple Interest} = \frac{p \times T \times R}{100}$$

Where

P = Principle\sum

T = time within year

R = rate of interest

Evolution

Find the rate when it is given principle, time and interest.

Teaching Episode II

Subject: Mathematics

Class: VIII

Topic: Simple Interest

Time: 45 min.

Specific objectives

At the end of this class, students will be able to find the solution of the problem related to simple interest.

Teaching learning activities

i) Posing a problem

In this phase, tutor will ask problem to the student and transform the real world problem to numerical.

Ram deposited a sum of Rs. 5000 at the rate 10% per year. How much amount did he receive at the end of 4 years?

ii) Work on the problem

In this phase, tutor will divide the small and interactive group for sharing their ideas and they will find numeral values from the problem with the help of tutor.

Principle= Rs. 5000, Rate = 10%, Time = 4 years

iii) Intervention as question arise

In this phase, tutor will give feedback of misunderstanding problem.

How to calculate rate?

What is rate of interest?

Students will share and exchanging works with other groups.

iv) Students apply scaffolding instruction

In this phase, tutor will watch over the students work and how they are using knowledge. Finally tutor will provide feedback and define each term.

v) A solution reached

Tutor will ask final solution and discuss about the solution in each group and give final solution.

$$\text{Simple Interest} = \frac{\text{Rs. } 5000 \times 4 \times 10}{100}$$

$$\text{Rs.} = 2000$$

$$\text{And amount} = \text{Rs. } 5000 + \text{Rs. } 2000$$

$$= \text{Rs. } 7000$$

He should receive Rs. 7000 at the end of the 4 years.

Evolution

In how many years will Rs. 960 produce Rs. 336 as simple interest at 7 % per annum?

Teaching Episode III

Subject: Mathematics

Class: VIII

Topic: Simple Interest

Time: 45 min.

Specific objectives

At the end of this class, students will be able to solve simple daily life problem related to simple interest.

Teaching learning activities

i) Posing a problem

In this phase, tutor will provide to student, present the problem of simple interest with daily live phenomena.

After discuss the problem tutor will select representative problem and translate mathematical way.

Anomal took a loan from NIC bank at 10% p.a. At the end of 2 years, he paid an amount of Rs. 7500 and clears the loan. Find the loan taken from the bank.

ii) Work on the problem

In this phase, tutor will divide small and interactive group for sharing their ideas and they will find the terms from the problem with the help of previous class videos and materials.

Here, Amount = Rs. 7500, Rate = 10%, Time = 2 years

iii) Intervention as question arise

In this phase, students will engage in different types of facilities and discuss the given questions.

What is the different among principle, interest and amount?

Why amount is more than principle within 2 years?

Tutor will provide the chance to students if they want sharing and exchanging work with other groups.

iv) Students apply scaffolding instruction

In this phase, tutor will watch over the students work and finally tutor will provide feedback and define each term.

v) A solution reached

Tutor will ask final solution and discuss about the solving process for each group and give final solution.

$$\begin{aligned}\text{Principle} &= \frac{A \times 100}{100 + TR} \\ &= \frac{\text{Rs.}7500 \times 100}{100 + 2 \times 10} \\ &= \text{Rs. } 6250\end{aligned}$$

The loan taken from bank is Rs. 6250.

Evolution

Find the sum of that amount to Rs. 8000 in 6 years at the rate of 10% per year simple interest.

Teaching Episode IV

Subject: Mathematics

Class: VIII

Topic: Simple Interest

Time: 45 min.

Specific objectives

At the end of this class, students will be able to solve simple daily life problem related to simple interest.

Teaching learning activities

i) Posing a problem

In this phase, student will present the problem related to simple interest of daily live phenomena.

After discuss the problem tutor will select representative problem and translate mathematical way.

Anomal took a loan from NIC bank at 10% p.a. At the end of 2 years, he paid an amount of Rs. 7500 and clears the loan. Find the loan taken from the bank.

ii) Work on the problem

In this phase, tutor will divide small and interactive group for sharing their ideas and they will find the terms from the problem with the help of previous class videos and materials.

Here, Amount = Rs. 7500, Rate = 10%, Time = 2 years

iii) Intervention as question arise

In this phase, students will engage in different types of facilities and discuss the given questions.

What is the different among principle, interest and amount?

Why amount is more than principle within 2 years?

Teacher will provide chance to students if they want sharing and exchanging work with other groups.

iv) Students apply scaffolding instruction

In this phase, tutor will watch over the students work and how they are using knowledge.

They are trying to achieve and finally teacher will provide feedback and define each terms.

v) A solution reached

Tutor will ask final solution and discuss about the solving process in each group and tutor give final solution.

$$\begin{aligned} \text{Principle} &= \frac{A \times 100}{100 + TR} \\ &= \frac{\text{Rs.}7500 \times 100}{100 + 2 \times 10} \\ &= \text{Rs. } 6250 \end{aligned}$$

The loan taken from bank is Rs. 6250.

Evolution

Find the sum of that amount to Rs. 8000 in 6 years at the rate of 10% per year simple interest.

Teaching Episode V

Subject: Mathematics

Class: VIII

Topic: Marked Price and Discount

Time: 45 min.

Specific objectives

At the end of this class, students will be able to derive the relation of marked price, discount and selling price.

Teaching learning activities

i) Posing a problem

In this phase, student present the open ended problem related to market price, selling price and discount amount in daily activities.

ii) Work on the problem

In this phase, tutor will divide small and interactive group for sharing their ideas and they will find the terms from the problem with the help of previous class and teacher.

iii) Intervention as question arise

In this phase, students will engage in different types of facilities and discuss the given questions.

What is marked price?

What is discount amount?

How to calculate discount percentage?

iv) Students apply scaffolding instruction

In this phase, tutor will watch over the students work and how they are using knowledge.

They are trying to achieve and finally tutor will provide feedback and define each terms.

The price of an article for sale as indicated by an attached label is called marked price

When a shopkeeper reduce price from the M.P. of any article and sells it to customers, the reduce price is called discount.

v) A solution reached

Tutor will ask final solution and discuss about the gain and loss percentage

Finally give the relation.

Discount amount = M.P. – S. P. or discount percent of M.P.

Discount percent = $\frac{\text{Discount amount}}{\text{M.P.}}$ or $\frac{\text{M.P.} - \text{S.P.}}{\text{M.P.}} \times 100$

Selling price = M.P – D% of M.P.

Evolution

The marked price of an article is 1000. It is sold allowing 20% discount and with 15% VAT. Find the amount of discount, amount of VAT and final selling price of the article.

Teaching Episode VI

Subject: Mathematics

Class: VIII

Topic: VAT amount

Time: 45 min.

Specific objectives

At the end of this class, students will be able define the VAT amount with examples.

Teaching learning activities

i) Posing a problem

In this phase tutor will provide to student, present the real problem related to VAT amount.

ii) Work on the problem

In this phase, tutor will divide small and interactive group for sharing their ideas and they will find the terms from the problem with the help of previous class.

iii) Intervention as question arise

In this phase, students will engage in different types of facilities and discuss the given questions.

What is VAT amount?

How much allowed VAT% in Nepal?

iv) Students apply scaffolding instruction

In this phase, tutor will watch over the students work and how they are using knowledge.

They are trying to achieve and finally teacher will provide feedback and define each terms.

Vat is levied on the cost of goods and service. The VAT is given in percent it is decided by the concerned authority of the government.

v) A solution reached

Tutor will ask final solution and discuss about the method of finding the solution.

Finally give the relation.

VAT amount = Rate of VAT \times S.P.

SP with VAT = SP + VAT amount

Evolution

The marked price of an article is 1500. It is sold allowing 15% discount and with 13% VAT. Find the amount of discount, amount of VAT and final selling price of the article.

Teaching Episode VII

Subject: Mathematics

Class: VIII

Topic: Unitary Method

Time: 45 min.

Specific objectives

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

Teaching learning activities

i) Posing a problem

In this phase, student will present the problem related to variation, ratios and unitary method, after present the problem finding the unknown variables and translate the problem it to mathematical way.

Ram bought 12 pencils for Rs. 120 what is the price of 1 pencil?

ii) Work on the problem

In this phase, tutor will divide small and interactive group for sharing their ideas and they will find the terms from the problem with the help of previous class and teacher.

The cost of 12b pencils = Rs. 120

The cost of 1 pencil = Rs. $120 \div 12 =$ Rs. 10

iii) Intervention as question arise

In this phase, students will engage in different types of facilities and discuss the given questions.

What is direct variation?

What is indirect variation?

What is different between direct and indirect variation?

iv) Students apply scaffolding instruction

In this phase, tutor will watch over the students work and how they are using knowledge.

They are trying to achieve and finally tutor will provide feedback and define each terms.

The method of finding the unit value or the value of more number of quantities by the process of division or multiplication is known as unitary method.

v) A solution reached

Tutor will ask final solution and discuss about the method of finding the solution.

Finally give the relation way to solve problem by variation method.

Evolution

- a.** If the cost of 15 pencils is Rs. 75 find the cost of 25 pencils.
- b.** If the cost of 5 chairs is Rs. 4800, find the cost of 12 chairs.

Teaching Episode VIII

Subject: Mathematics

Class: VIII

Topic: Variation

Time: 45 min.

Specific objectives

At the end of this class, students will be able to define the variation with examples.

Teaching learning activities

i) Posing a problem

In this phase, tutor will provide to student, present the problem related to variation, ratios and unitary method, after present the problem finding the unknown variables and translate the problem it to mathematical way.

Hari bought 1 pen for Rs.10 what is the price of 10 pens?

10 boys can complete a work 48 in days. In how many days will 30 boys complete the same work?

ii) Work on the problem

In this phase, tutor will divide small and interactive group for sharing their ideas and they will find the terms from the problem with the help of previous class and teacher.

The cost of 1 pen = Rs. 10

The cost of 10 pens = Rs. 10×10 = Rs. 100

iii) Intervention as question arise

In this phase, students will engage in different types of facilities and discuss the given questions.

What is direct variation?

What is indirect variation?

What is different between direct and indirect variation?

iv) Students apply scaffolding instruction

In this phase, tutor will watch over the students work and how they are using knowledge.

They are trying to achieve and finally tutor will provide feedback and define each terms.

In direct variation, the value of quantity is obtained by dividing the value of any quantity by that quantity and the value of quantity is obtained by multiplying the value of unit quantity by that quantity.

In inverse or indirect variation, the unit value is obtained by multiplying the value of any quantity by that quantity and the value of more quantities is obtained by dividing the quantity by that quantity.

v) A solution reached

Tutor will ask final solution and discuss about the method of finding the solution.

Finally give the relation to solve problem by variation method.

Evolution

- a. If 10 man earns Rs. 1800 for 24 days, how much will 15 man earn in 20 days?
- b. If the cost of 5 chairs is Rs. 4800, find the cost of 12 chairs.

Teaching Episode IX

Subject: Mathematics

Class: VIII

Topic: Application of Unitary Method

Time: 45 min.

Specific objectives

At the end of this class, students will be able to solve the simple problem related to unitary method.

Teaching learning activities

i) Posing a problem

In this phase, tutor will provide to student, present the problem related to unitary method.

ii) Work on the problem

In this phase, tutor will divide small and interactive group for sharing their ideas and they will find the terms from the problem with the help of previous class and tutor.

In unitary method, discuss with three things.

The number of required workers.

The number of required days.

The quantity of work.

iii) Intervention as question arise

In this phase, students will engage in different types of facilities and discuss the given questions.

How to solve by problem by direct variation method?

How to solve problem by indirect variation method?

What is application of unitary method?

iv) Students apply scaffolding instruction

In this phase, tutor will watch over the students while solving the problem. They are trying to achieve and finally tutor will provide feedback and define each terms while solving the problem on unitary method.

Tutor will define following facts.

- More number of workers does more work and less number of worker do less work. So the number of workers and amount of work are directly proportion.
- More number of workers takes less time and less number of workers take more time. So, number of workers and time are inversely proportional.
- If more number days, more amount of work is done and less number of days, less number of work is done. So, the number of days and amount of work done are directly proportional.

v) A solution reached

Tutor will ask final solution and discuss about the process.

Evolution

A can do a piece of work in 20 days and B can do it in 30 days. If they work together, in how many days would they finish the work?

Teaching Episode X

Subject: Mathematics

Class: VIII

Topic: Definition of Ratios

Time: 45 min.

Specific objectives

At the end of this class, students will be able to define the ratios.

Teaching learning activities

i) Posing a problem

In this phase, tutor will provide to student, present the problem of ratios related real problem. Tutor translate the problem in mathematics way.

Suppose Ram has Rs. 10 and Shyam has Rs. 5.

ii) Work on the problem

In this phase, tutor will divide small and interactive group for sharing their ideas and knowledge, they will find the terms from the problem with the help of previous class.

One way to compare their money is by subtraction. Since $\text{Rs. } 10 - \text{Rs. } 5 = \text{Rs. } 5$, Ram has Rs. 5 more than Shyam. Tutor will compare their money by division also.

Since $\frac{\text{Rs. } 10}{\text{Rs. } 5} = 2$ Ram has two times as much as money as Shyam has.

iii) Intervention as question arise

In this phase, students will engage in different types of facilities and discuss the given questions.

How much difference between the money they have?

How much more money has Ram than Shyam?

How much less money has Shyam than Ram?

iv) Students apply scaffolding instruction

In this phase, tutor will watch over the students work for how they are using and utilize knowledge.

v) A solution reached

Tutor will watch over the solution and discuss the about ratios. From the above relation conclude that.

A comparison of quantities of the same kind by division is called ratio.

Thus, a ratio tells how many times a quantity is greater or smaller than another quantity of the same kind.

Evolution

Find the ratios of age of you to every member in your family.

Find the ratio of boys and girls in your class.

Teaching Episode XI

Subject: Mathematics

Class: VIII

Topic: Types of the Ratios

Time: 45 min.

Specific objectives

At the end of this class, students will be able to define the types of ratio.

Teaching learning activities

i) Posing a problem

In this phase tutor will provide to student, present the problem and discuss about the problem and take one problem representative of all problem.

ii) Work on the problem

In this phase, tutor will divide small and interactive group for sharing their ideas and knowledge, they will discuss about the types of problem.

Compound ratios.

Duplicate and sub-duplicate ratio.

Triplicate and sub-triplicate ratio.

Inverse ratio.

iii) Intervention as question arise

In this phase, students will engage in different types of facilities and discuss the given questions.

What is compounded ratio?

What is Duplicate and sub-duplicate ratios?

What is triplicate ratios?

What is inverse ratios?

iv) Students apply scaffolding instruction

In this phase, tutor will watch over the students work and how they are using knowledge.

The compounded ratio is the product of two or more ratios.

When it is compounded with itself a new ratio of square terms so formed is called duplicate ratio.

When it is multiply by itself three times, a new ratio of cube terms so formed is called triplicate ratio.

The interchange the antecedent and consequent the new ratio is formed is called the inverse ratio.

They are trying to achieve and finally tutor will provide feedback and define each terms.

v) A solution reached

Tutor will ask final solution and discuss about the terms and from the problem and give final definition.

Evolution

Define all ratios with example.

Teaching Episode XII

Subject: Mathematics

Class: VIII

Topic: Ratios Problem

Time: 45 min.

Specific objectives

At the end of this class, students will be able to solve simple daily life problem based on ratio.

Teaching learning activities

i) Posing a problem

In this phase, tutor will provide to student, present real and ill-structure problem and discuss about the problem translate to mathematical problem.

The ratio of age of Sita and Gita is 4: 3. If the age of Gita is 12 years, what is the age of Sita?

ii) Work on the problem

In this phase, tutor will divide small and interactive group for sharing their ideas and knowledge.

The ratios of Sita and Gita age are 4 : 3 than obviously Sita age is greater than Gita age.

iii) Intervention as question arise

In this phase, students will engage in different types of facilities and discuss the given questions.

What is the age difference of them?

Can multiple of real age and ratios of age?

iv) Students apply scaffolding instruction

In this phase, tutor will watch over the students work and how they are using knowledge in given problem.

Let the age of Gita and Sita be $3x$ and $4x$

But real age of Gita is 12 years, compare the age i.e. $3x = 12$ and $x = 4$, also Sita age is $4x$ then $4 \times x = 4 \times 4 = 16$

They are trying to achieve and finally tutor will provide feedback and define of each terms.

v) A solution reached

Tutor will ask final solution and discuss about the terms and from the problem and give final definition.

The real age of Sita is 16 years.

Evolution

The ratio of the present age of Sunayana and her mother is 1: 4. After 6 years, the ratio of their ages will be 5: 14. Find their present ages.